A Sustainable Vision for Mulberry St.

Prof. Virginia Russell
John Arend
Steve Bassett
Mike Benkert
Katie Dyer
Cythia Fels
Jessica Linz
Carl Sterner
Valerie Vrable

Table of Contents

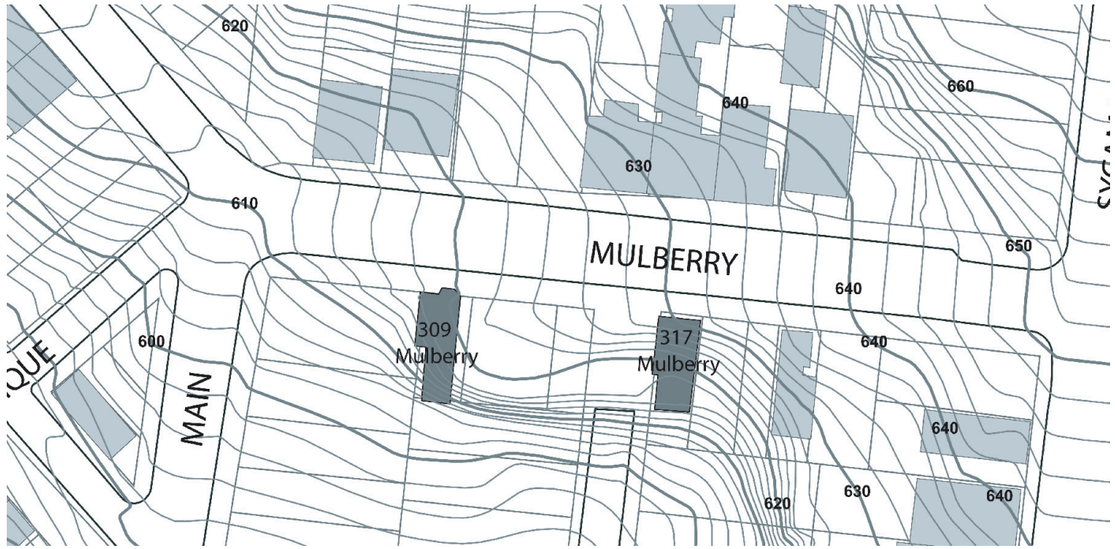
Goals and Objectives

IS SUSTAINABLE LOW INCOME DESIGN POSSIBLE?

This project is an attempt to study the possibility of sustainable design as it applies to low-income housing. We believe that it is possible to provide quality housing that meets the needs of the environment, while still being affordable. To prove this, we have created a study of two homes in Cincinnati - renovating them to make them as sustainable as possible.

RENOVATIONS OF 309 AND 317 MULBERRY ST.

We have chosen two properties in Over the Rhine - 309 and 317 Mulberry St. Two properties on the block have already been redeveloped, and our project hopes to build on this trend. There is a community garden nearby, and there are also some open basketball courts. There is a school nearby that could be reopened, and the whole neighborhood seems ready for revitalization.



Context Map

Elevational Panorama

Sustainable Low Income Housing

1.2

WHAT MAKES SOMETHING SUSTAINABLE?

Sustainability is the art of design that takes into account the ecological, economic, and social impacts of a situation over a long term basis. Good sustainable design provides the best possible outcome now and for the future.

Social sustainability is design that can benefit all members of society, and discriminates against none. This includes universal design, community planning, and the continuation of quality human interaction.

Ecological sustainability includes effects on the environment, our ecosystem, and the limited resources of our planet.

Economic sustainability includes the production of goods and services in a manner that can be continued. It takes into account the life-cycle cost of items, and the overall impact of a good on it's economy.

LOW INCOME HOUSING:

In this area of Over the Rhine, the common demographic is larger families with low incomes. Because of this, we feel that the area primarily needs houses that have multiple units, with apartments that have 3 bedrooms. Access to alternative modes of transportation is also important in a low income situation, so the proximity of bus lines is important. Yardspace is also key to creating a feeling of ownership and community in the neighborhood.

WHY AFFORDABLE?

Sustainable design is about the community and the people involved as much as it is about the environment. In the neighborhood of Over the Rhine, a majority of families are low-income. Because we believe that home ownership is important, we want these homes to be available to the people who live in the neighborhood.

Looking up Mulbery St.

STRATEGIES TO ACHIEVE SUSTAINABILITY

PASSIVE STRATEGIES:

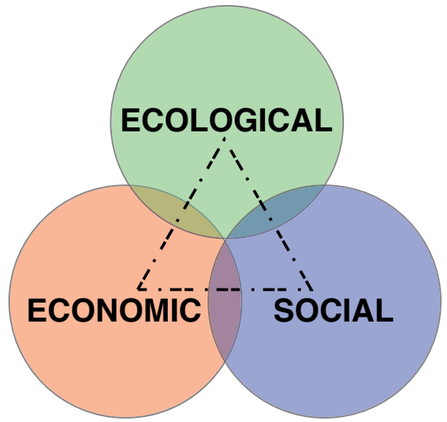
By utilizing passive strategies first, this makes the most out of existing conditions, and limits the need for gadgets and large lifestyle changes. It also lessens the load that mechanical systems are required to carry, being more energy efficient and therefore less costly. Utility bills can be dramatically lowered by implementing these passive strategies, saving inhabitants money. Over time, the costs of utilities can add up, and lessening the impact of these bills on a low income family can greatly improve the quality of life for the inhabitants. In addition to saving the inhabitants money, these strategies improve the quality of the spaces that are inhabited. The first of these is passive daylighting. Daylighting provides a more pleasant space for living, and also limits the need for extra electrical lighting. Designing for the most effective daylighting can make the need for electric lighting only a necessity in the late evening and the early morning. Another important passive strategy is passive ventilation. This allows for air to flow freely through the building, and helps with cooling in the summer. Air movement is very important in the humidity of Cincinnati, especially in the summer. Passive cooling strategies also include natural shading, and attempts to prevent heat from entering the building during the hot months. The deciduous trees on the southern and western exposures of the building provide this shading. Passive heating, on the other hand, takes advantage of the sun to warm the building without a large mechanical unit. The trombe wall design we have created takes the most advantage of this passive heating, and uses the existing thermal mass of the bricks to heat the building in the winter.

ACTIVE STRATEGIES:

By utilizing the most efficient and appropriate active systems for our site, we can limit the amount of energy that we waste, and can help to keep costs down for the inhabitants. By making systems that come from a renewable energy, we lessen the environmental impact of our project.

RENOVATION AND SALVAGED MATERIALS:

By renovating existing buildings instead of constructing new buildings, we are reusing the old structures that might otherwise stay vacant, and are making the most out of the existing structures. We also minimize the cost of the project by building upon something that already exists.



When considering our design strategies, we are always keeping in mind the sustainable aspects of our design. This includes looking at our ideas from all points of sustainability - Ecological, Economical, and Social.

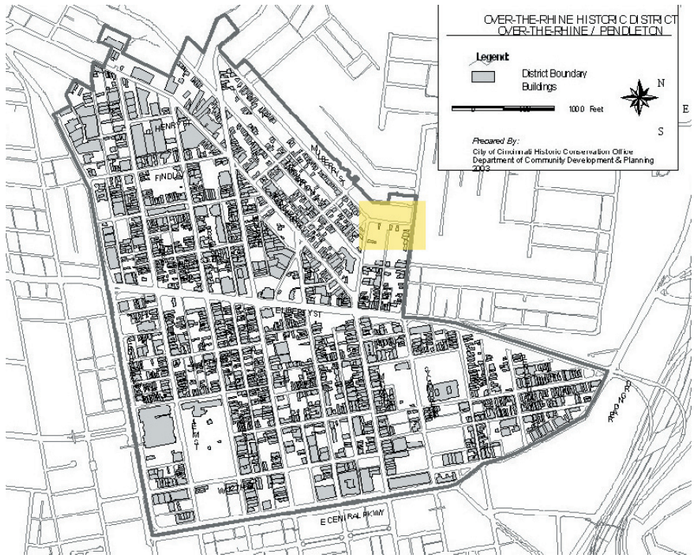
309 Mulbery

317 Mulbery

Current Site Conditions

SITE LOCATION

The site which we have selected to develop in a sustainable and affordable manner is located along the eastern edge of Over-the-Rhine, on Mulberry Street, between Sycamore and Main Street. The two houses, and the additional properties we plan to purchase (which are explained in more detail on the next page) run along the southern side of Mulberry Street, from the intersection with Main to the eastern border of the 317 property, about half-way between Main and Sycamore Street.



NEGATIVES OF THE SITE

-TOPOGRAPHY AND EROSION: The elevation changes and slopes on the site are quite steep at several locations, but especially around the buildings themselves. As a result, erosion is one of the major problems the site presents.

-TREES AND OVERGROWN VEGETATION: The current site has several trees growing too close to the buildings and a number of dead trees, which present problems for the existing buildings and site. Excessive amounts of vegetation running up and around the buildings also endanger the buildings' structure and are a aesthetically unappealing.

-LACK OF PUBLIC AND PRIVATE OUTDOOR SPACES: Although there is a decent amount of usable land between 309 and 317, it has remained an unused and undeveloped, and is more or less, a visual eyesore.

POSITIVES OF THE SITE

-SOLAR ORIENTATION: The 309 and 317 buildings are oriented in a manner where the majority of the living spaces and glazing are oriented south

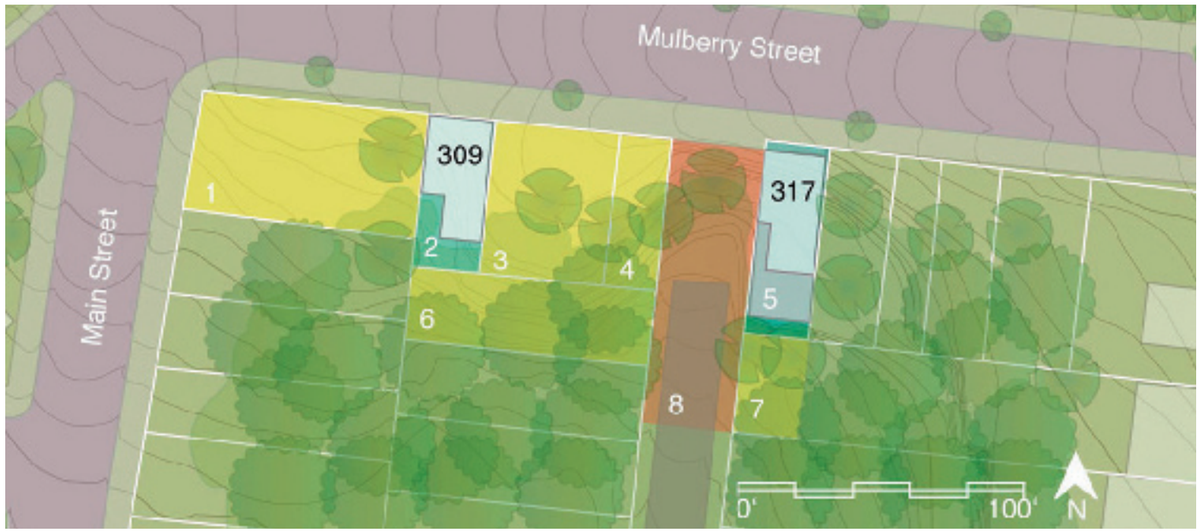
-LOCATION: The site is close to public transportation as well as downtown Cincinnati so there are plenty of opportunities to get around the city without the aid of a car.

-REDEVELOPMENT POTENTIAL: The site is located in one of the safer areas of Over-the-Rhine with the properties across the street actually being part of Mt. Auburn. A couple of the buildings across from 317 have recently been renovated, so there is precedent for what we are proposing.

CURRENT SITE PLAN

Property Purchases and Hierarchy Diagrams

PROPERTY PURCHASES DIAGRAM



PARCEL #	ADDRESS	PROPERTY COST	PROPERTY COST W/ HOUSE	PLAN #
8600030001-00	1738 Main Street	$5,300		1
8600030015	309 Mulberry Street	$5,500	$61,000	2
8600030016-00	311 Mulberry Street	$6,500		3
8600030017-00		$3,300		4
8600020001	317 Mulberry Street	$6,700	$59,200	5
08600030018-90	Hughes Street	$3,400		6
08600020008-90	Hughes Street	$4,000		7
Condemned Lot	Hughes Street	$0		8

EXPLANATION OF PROPERTY PURCHASES:

-As a result of purchasing the two properties between 309 and 317 and condemning the strip of land where Hughes Street runs into the retaining wall beneath Mulberry Street, we now have the opportunity to develop a shared outdoor space for the two buildings with different levels of privacy that will enhance the quality of life for all users within the units. It also gives the ability to make one of the units in 309 handicapped accessible and a place to install our geo-exchange system.
-By purchasing the properties directly behind 309 and 317 we ensure ourselves that our passive heating and cooling strategies will remain uninterrupted from any future building projects. This is very important in that many of our sustainable strategies rely heavily on solar orientation and air flow.
-Finally, from purchasing the property on the corner of Main and Mulberry Street, we not only ensure the effectiveness of many of our sustainable strategies, we also gain land, which can be used for the planting of shade trees and vegetable gardens.

PRIVATE/PUBLIC HIERARCHY DIAGRAM

PRIVATE SPACES: All four units within the two buildings will feature their own private decks, which will be isolated (in a variety of ways) from the rest of the property. For the units at 309, these decks are to be located along the east facing wall, and for the units at 317, these decks will be located along the south facing walls.

SEMI-PRIVATE SPACES: These spaces are to be shared by the units within one building or the other, but isolated from the rest of the site. These spaces will include portions of the 309 deck, the 317 deck/bridge, and the plantings and gardens possessed by the individual buildings.

SEMI-PUBLIC SPACES: This area will include all of the leftover lawn and landscape within the site development that isn't part of the Private or Semi-Private spaces. The Semi-Public spaces are to be shared by all residents living in 309 and 317.

PUBLIC SPACES: The public spaces will encompass all of the property purchased that won't be part of the site development itself. This space is to be open to the public, despite much of it being uninhabitable due to trees, vegetation, and slope.

PRIVATE/PUBLIC HIERARCHY DIAGRAM

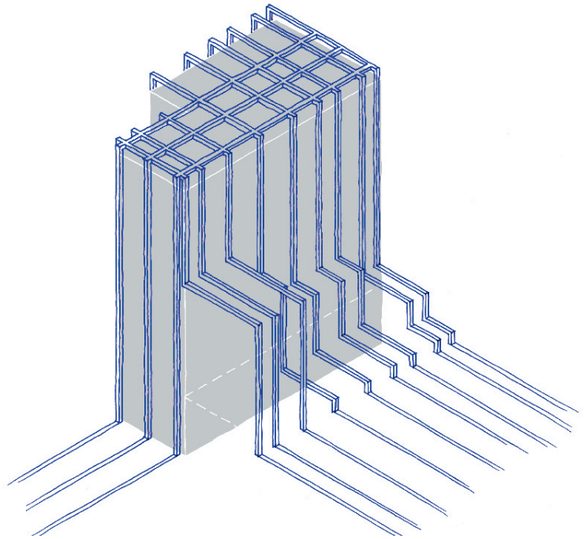
Site Development Concepts

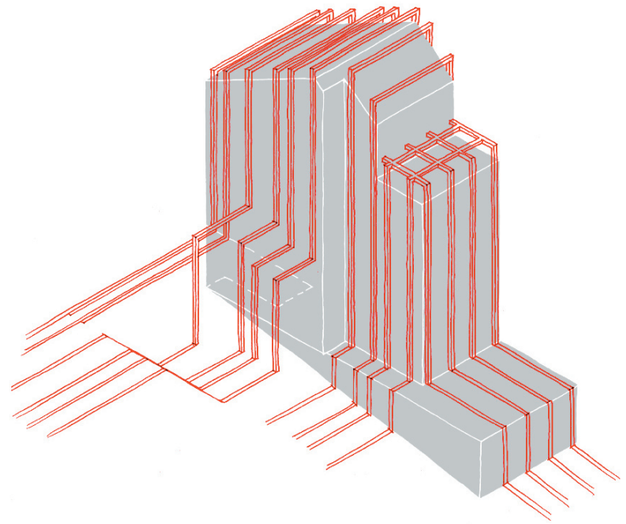
CONCEPT: FORCE LINES

A three-dimension grid of “force lines” wraps the existing buildings, establishing the underlying geometrical structure of the salvaged-window Trombe wall, the semi-private decks, and the exterior site development. The force lines were generated by explorations of the Trombe wall design, and are established by the existing window grid of each building.

This strategy (1) unifies the proposed design elements, (2) visually distinguishes the old and new construction, and (3) metaphorically and literally embraces the existing buildings, offering a measure of protection, both thermal (trombe wall) and experiential (off-street entrances).

The structural members that follow these force lines use the same architectural language: vertical structural members are dominant and horizontal are subservient.



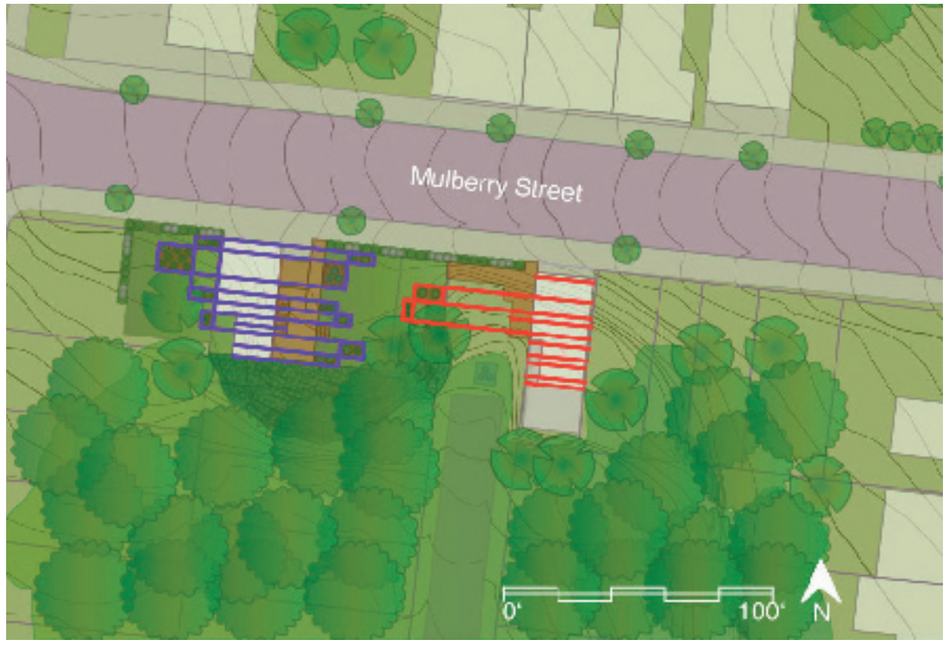


DESIGN STRATEGIES:

-TROMBE WALL GRID: One of the signature features of our rehabilitation project is the trombe wall system we have developed to wrap around the two buildings. This trombe wall system made up of salvaged windows forms a corresponding structural grid that is carried out onto the decks and into the site. The decks pick up on this system in the form of trellises and structural supports while the site incorporates this grid in the layout of its beds for plants gardens, and geoexchange caps.

-EXPOSED GEOEXCHANGE MOTIF: One of the sustainable strategies that is partially responsible for the heating and cooling of the units on our site is the geoexchange system that goes along with each building. For the 309 building, the geoexchange caps are exposed to express the significance of the system to the entire neighborhood and to further emphasize this motif, similar structures are expressed around the perimeter in the form of bollards made out of salvaged cylindrical air ducts housing various plant types.

SITE LINES AND GRID CONCEPT DIAGRAM



Proposed Site Plan and Strategies

SUSTAINABLE SITE STRATEGIES

1-Clover lawn: By using clover instead of grass for the lawns within the site, the property will no longer require mowing, which is harmful to the environment, expensive, and requires manual labor.

2-Natural Erosion Control: To help control erosion on the site's steep slopes, local perennial plants and/or ornamental grasses are to be planted so that their roots can help anchor the soil. Hosta and Sweet Woodruff plants are two local species that will work well in this situation.

3-Geoexchange System: The geoexchange system will be one of the more significant sustainable strategies implemented in our redevelopment project and therefore, needs to be expressed in the site design. This will be done by exposing the geoexchange caps for 309 that sit in one of the beds in the common yard between the buildings. The geoexchange system for 317 will remain buried in the area near Hughes Street.

4-Local Plants and Materials: In compliance with LEED standards, all plants and materials used in this development are to be shipped to the site from a location within a 500 mile radius of the site, and the great majority from within 100 miles.

5-Salvaged Materials: To reflect the nature of the exposed Geoexchange caps, salvaged cylindrical air ducts (which we call bollards) will be used throughout the perimeter borders as planters. They will be filled with soil, various cuts in the ducts will be made so that the greenery can pour out the edges of the structure.

6-Recycled Materials: Both decks are to be entirely composed of recycled composite materials and dimensioned in such a manner that very little, if any lumber will be wasted.

7-Organic Gardens: By providing the residents in 309 and 317 with gardens to grow their own food, not only will they save money, they will help conserve energy otherwise used in growing, packing, and selling commercial produce.

8-Shade Trees: While some trees will be removed for safety and design purposes, many trees will be retained with one additional tree being planted to shade the house from the hot summer sun and protect against cold winter winds.

9-Covered Bicycle Storage: To encourage the use of alternative transportation methods, both buildings will be equipped with their own covered bike storage on street level.

10-Cisterns: Will collect and store storm water run off for irrigation and other appropriate uses.

Minimal Site Disturbance: While many changes will be made to the site, almost all of the alterations are non-invasive (with the exception tree removal). The new construction for the decks and drilling for the geoexchange system will result in minimal if any site disturbance.

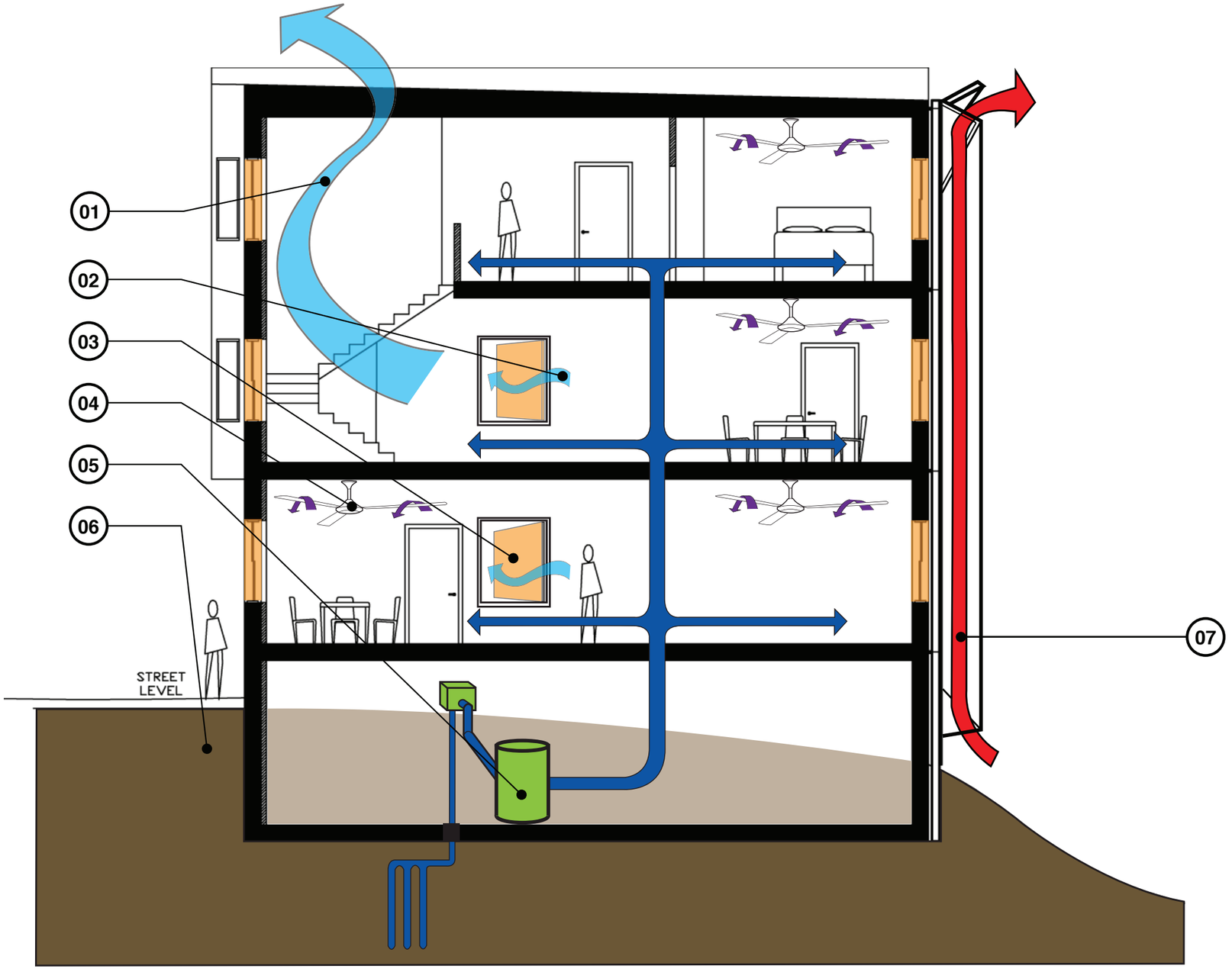
NECESSARY SITE ALTERATIONS

-TREE REMOVAL: The most invasive alteration that will be made to the site (with the exception of the Geoexchange drilling) is the removal of trees from the development. Four trees will be cut down from the site with one of them being replaced by a tree from a local sustainable forest (that replaces all the trees that are harvested). Trees on this site will only be removed if they are dead or endangering the structural integrity of the buildings themselves.

-OVERGROWN VEGETATION CLEARING: One of the problems with the current site on Mulberry Street is the amount of overgrown vegetation. Not only does it bring down the visual appeal value of the site as a whole, the weeds and vines growing up the buildings can also potentially damage the structure (if left untreated). For these reasons, clearing out all overgrown vegetation in and around the site development is a major priority.

PROPOSED SITE PLAN

System Diagrams



309 SUMMER SYSTEMS

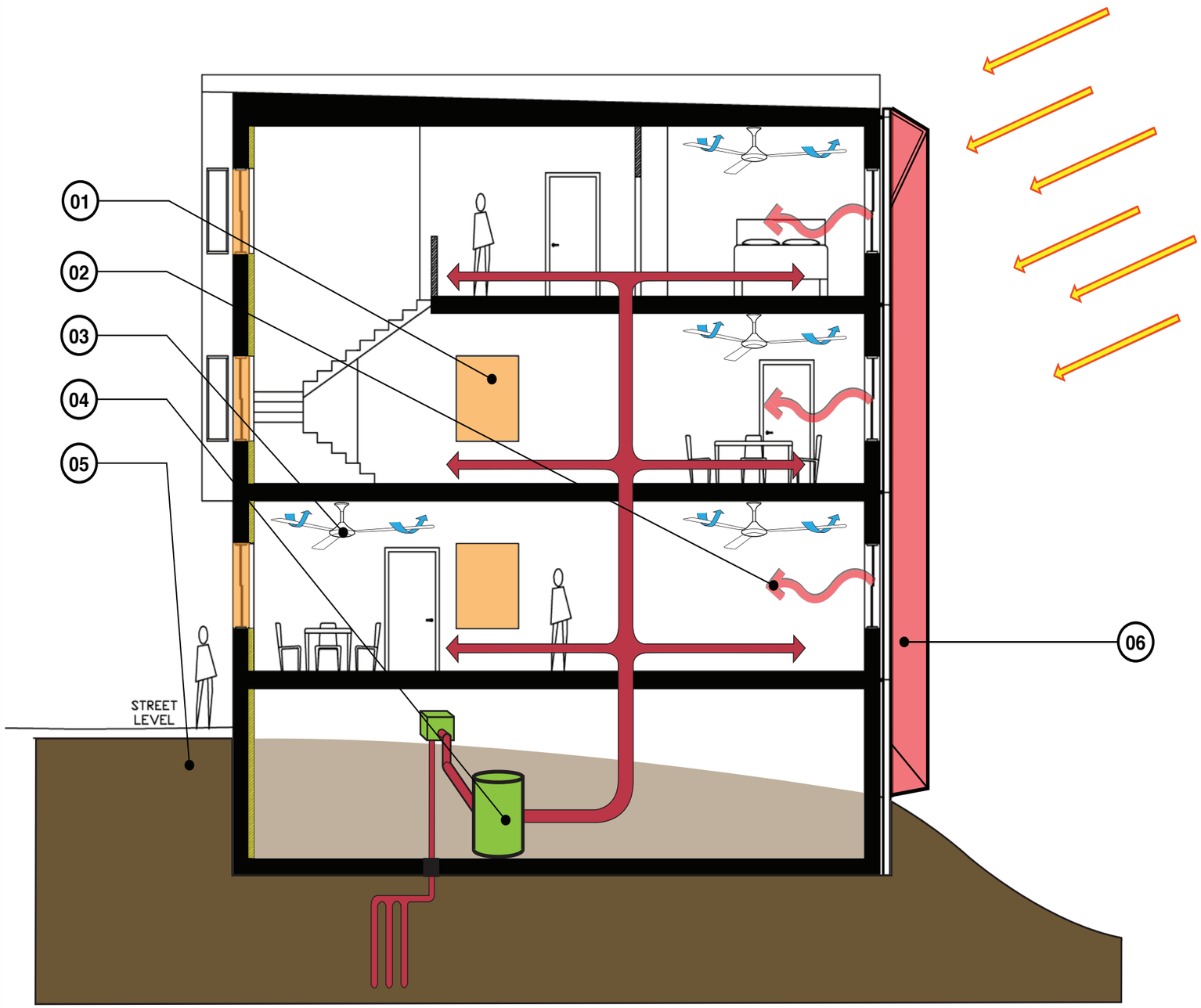
This diagram illustrates how our major systems operate during the summer months.

- Geoexchange System
- Energy Efficient Windows
- Cross Ventilation and Stack Effect
- Trombe Wall Venting and Infiltration
- Ceiling Fans
- Insulation
- Solar Gain

Callouts

1. stack effect
2. cross ventilation
3. windows with high SGHC factor that allows in light while keeping out heat
4. ceiling fans create cooling affect
5. geoexchange system uses earth's residual temperature to cool
6. earth berm
7. trombe wall vents open for air circulation

System Diagrams



309 WINTER SYSTEMS

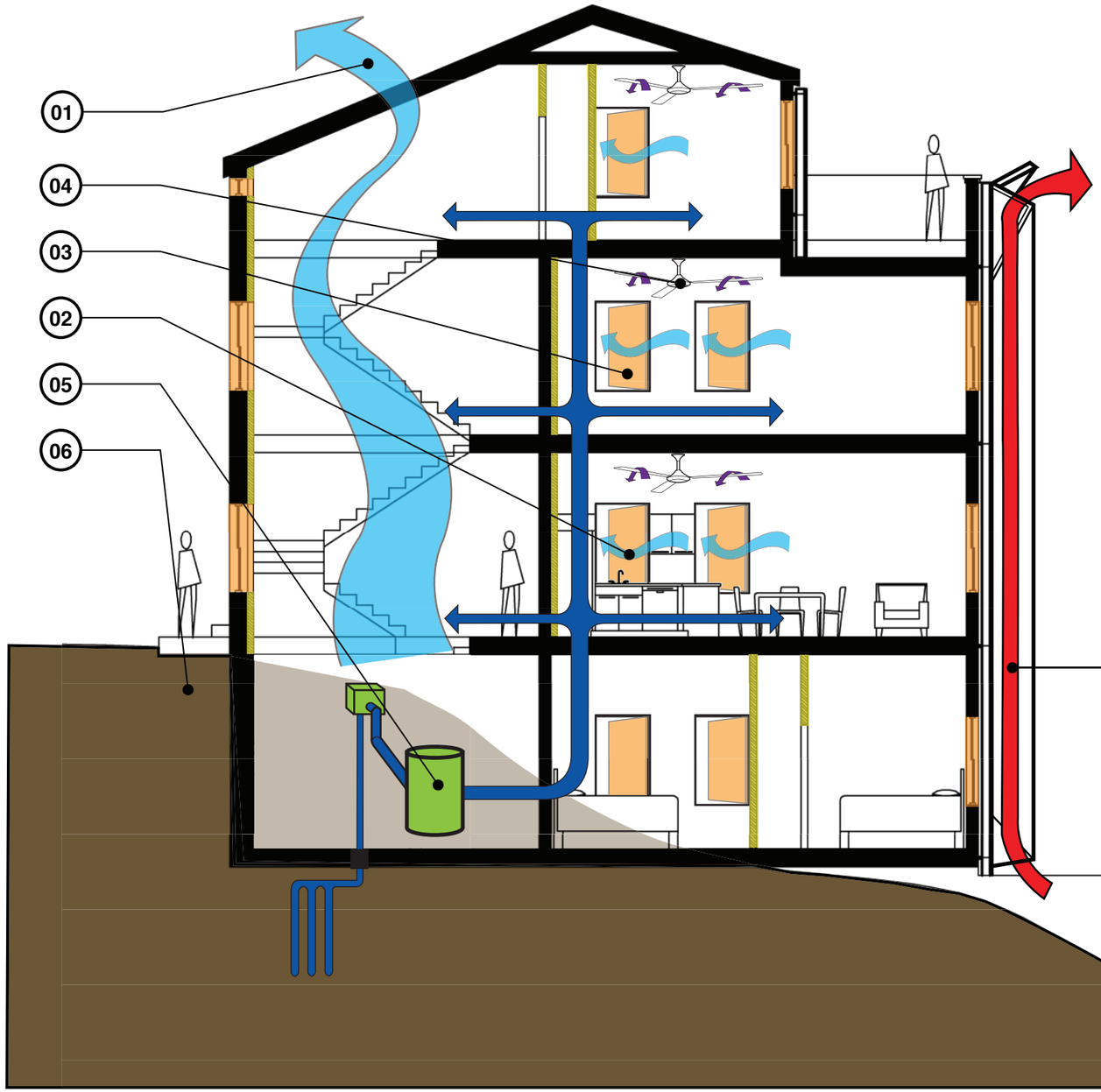
This diagram illustrates how our major systems operate during the winter months.

- Geoexchange System
- Energy Efficient Windows
- Cross Ventilation and Stack Effect
- Trombe Wall Venting and Infiltration
- Ceiling Fans
- Insulation
- Solar Gain

Callouts

1. high u-factor windows keep heat in and the cold out
2. radiant heat from trombe wall heats space
3. ceiling fans run reverse to circulate warm air that collects at the ceiling
4. geoexchange system takes advantage of the earth's residual warmth to heat
5. earth berm
6. sun heats trombe wall

System Diagrams



317 SUMMER SYSTEMS

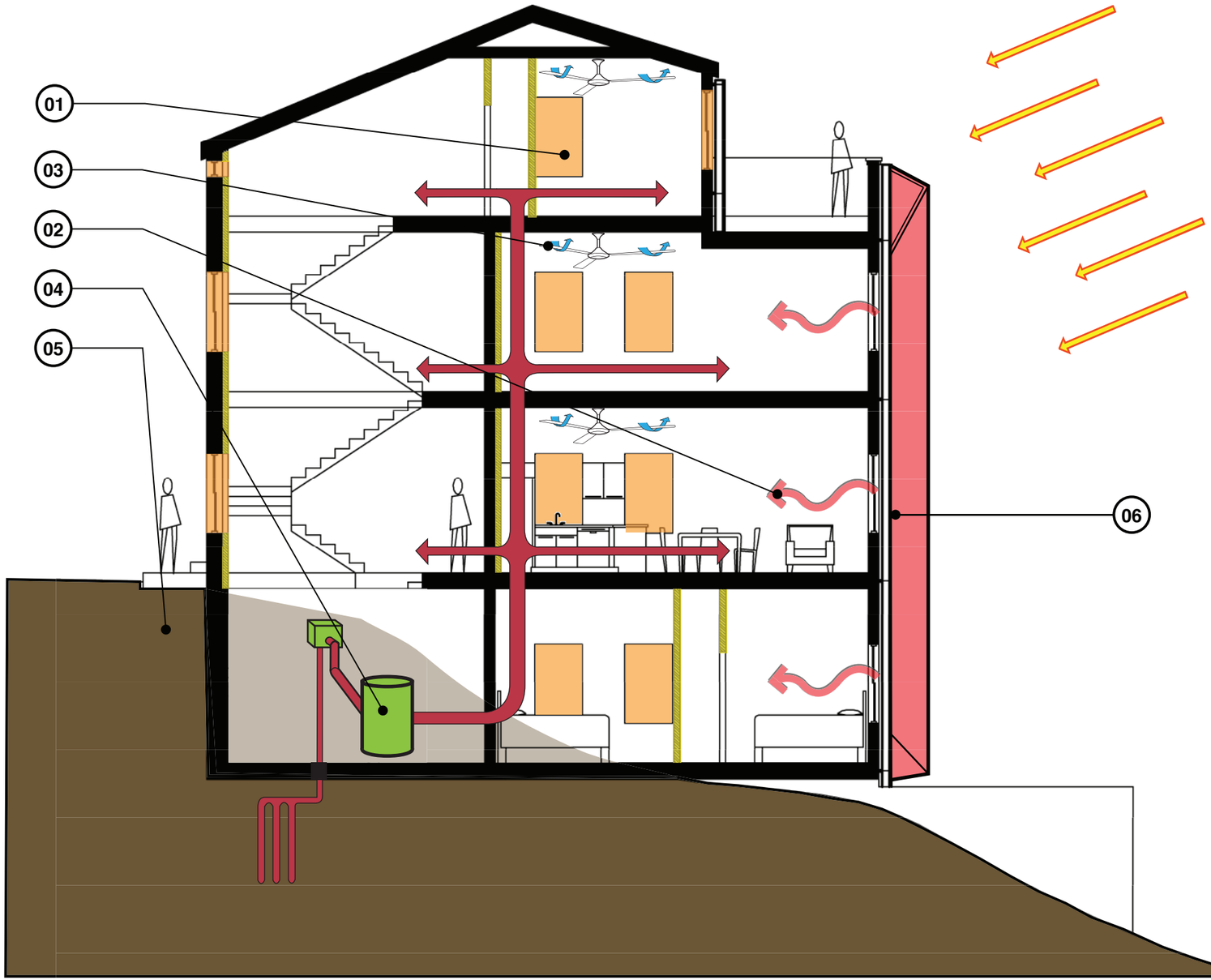
This diagram illustrates how our major systems operate during the summer months.

- Geoexchange System
- Energy Efficient Windows
- Cross Ventilation and Stack Effect
- Trombe Wall Venting and Infiltration
- Ceiling Fans
- Insulation
- Solar Gain

Callouts

1. stack affect
2. cross ventilation
3. windows with high SGHC factor that allows in light while keeping out heat
4. ceiling fans create cooling affect
5. geoexchange system uses earth's residual temperature to cool
6. earth berm
7. trombe wall vents open for air circulation

System Diagrams



317 WINTER SYSTEMS

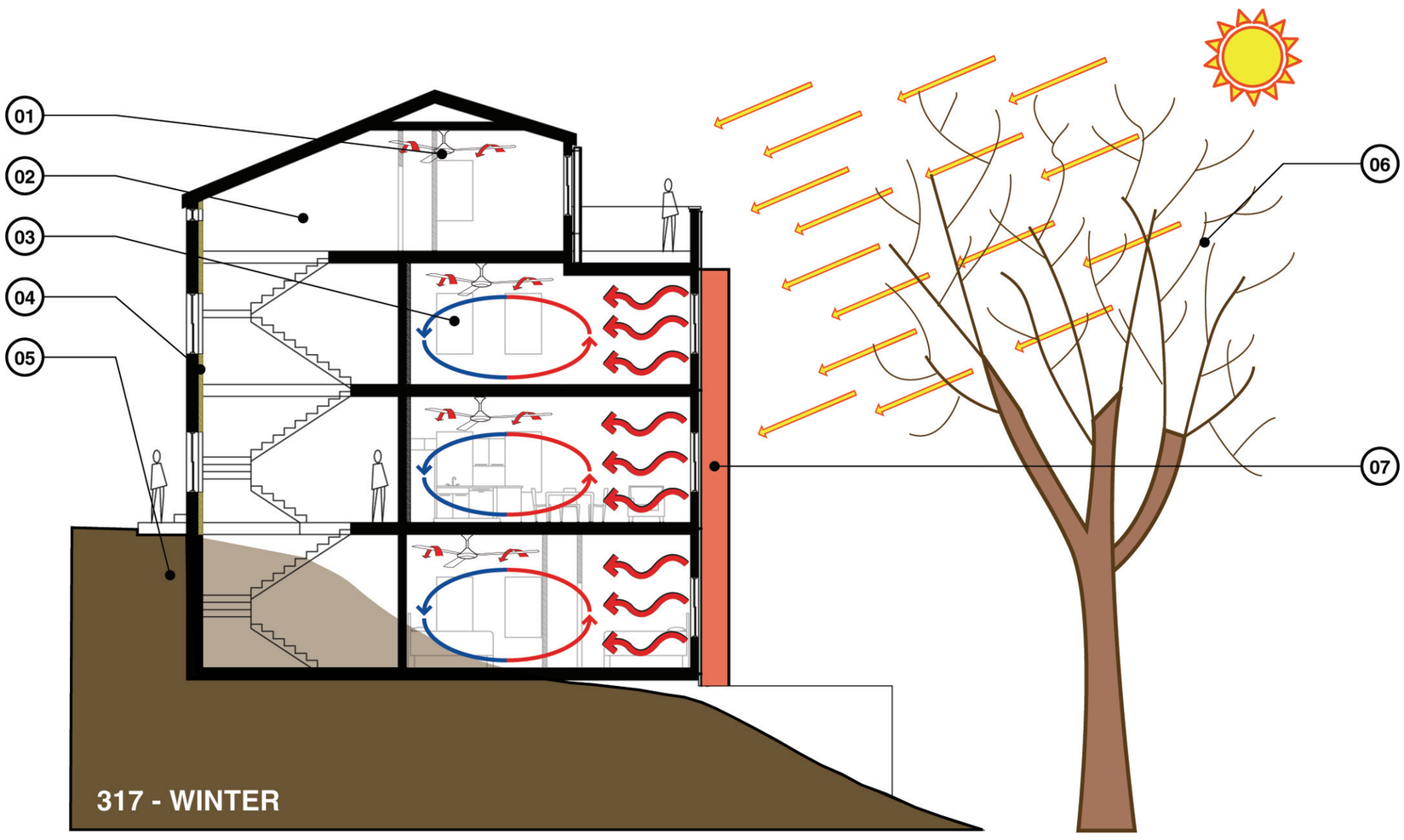
This diagram illustrates how our major systems operate during the winter months.

- Geoexchange System
- Energy Efficient Windows
- Cross Ventilation and Stack Effect
- Trombe Wall Venting and Infiltration
- Ceiling Fans
- Insulation
- Solar Gain

Callouts

1. high u-factor windows keep heat in and the cold out
2. radiant heat from trombe wall heats space
3. ceiling fans run reverse to circulate warm air that collects at the ceiling
4. geoexchange system takes advantage of the earth's residual warmth to heat
5. earth berm
6. sun heats trombe wall

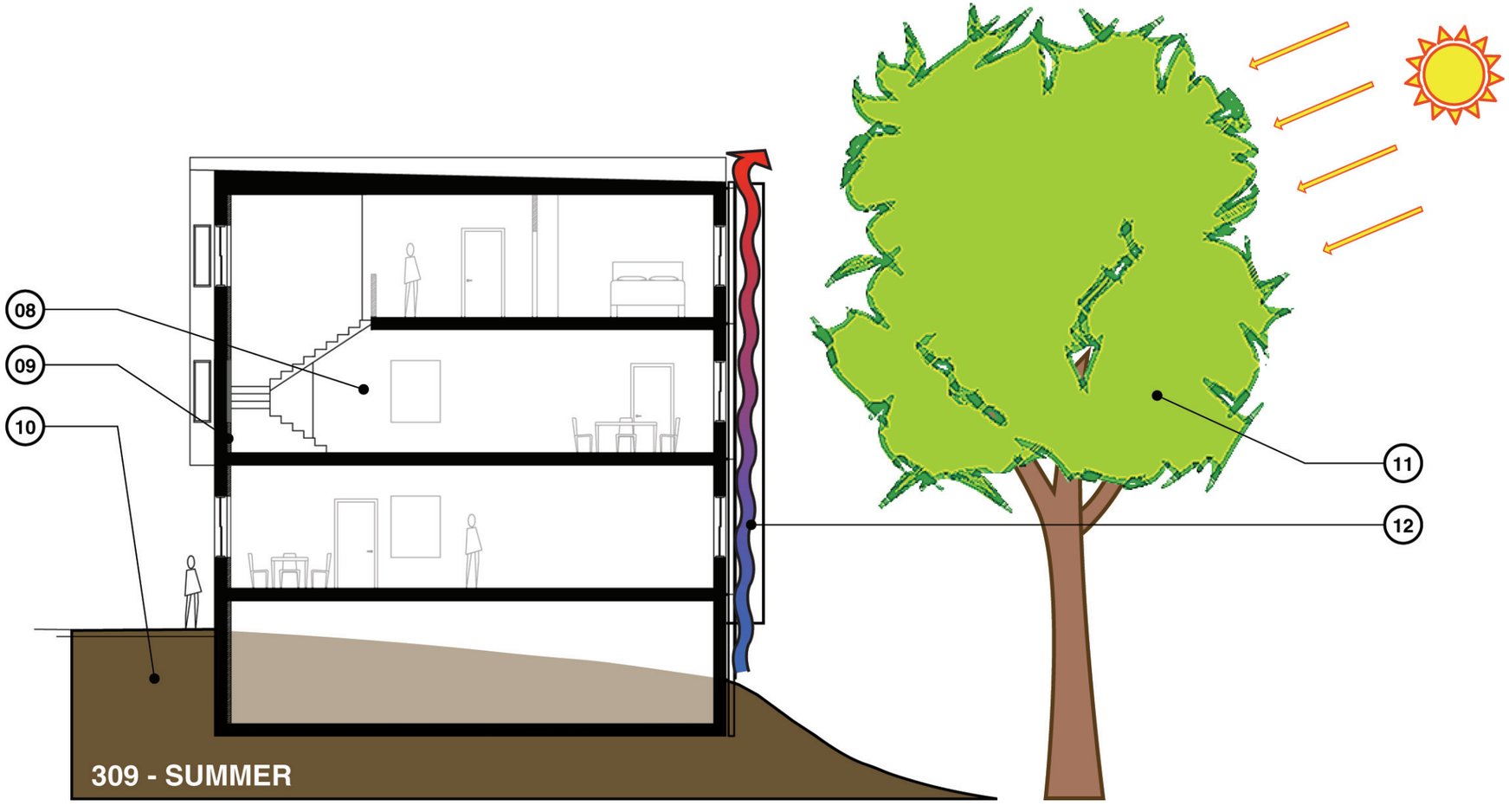
Solar Systems: Passive Solar



WINTER HEATING

1. **ceiling fans** run in reverse, circulating warm air that collects at the ceiling
2. **smaller volume** is easier to heat
3. **heat circulates naturally** through the open plan of the living spaces
4. **added batt insulation** keeps heat inside
5. **earth berm** helps keep the basement warm
6. **deciduous trees** loose leaves and allow sunlight through
7. **trombe wall** (direct gain) system on south and west facades

Solar Systems: Passive Solar



SUMMER COOLING

8. **interior cooling** provided by passive ventilation & geoexchange
9. **added batt insulation** keeps coolth inside
10. **earth berm** helps keep basement cool
11. **deciduous trees** shade southern and western trombe walls
12. **trombe wall ventilated**

DAYLIGHTING

DAYLIGHTING

Daylighting is one of the most important passive strategies. Artificial lighting consumes a great deal of energy and produces heat that adds to the summer cooling load.

Daylighting was provided through existing windows, new windows in the eastern façade of both buildings (located to facilitate both daylighting and passive ventilation), and a solar tube on the third floor of 317 Mulberry.

The proposed design effectively daylights all major occupied spaces (with the exception of the kitchen on the first floor of 309 Mulberry) well beyond the minimum Daylight Factor (DF) of 2.0% specified by LEED v.2.1. (DF is the ratio of exterior illumination to interior illumination.) In 309, 83% of occupied spaces are daylit, and 100% are daylit in 317.

WINDOW TYPE

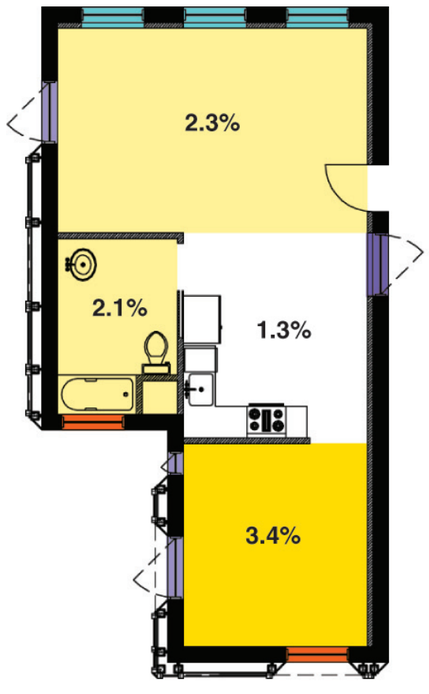
There are several kinds of window types in the proposed design. Each type has been selected for both performance and low cost.

1. **New Double-Hung Windows:** These replace existing windows on the north and south façades. They were chosen for two reasons: (a) to preserve the historic façade along Mulberry Street, and (b) to match the existing windows being kept on the south.
2. **New Casement Windows:** These replace existing windows on the west façade of both buildings. They were chosen because they allow greater airflow than double-hung windows (90% opening compared to 45% opening).
3. **New Casement Windows in New Opening:** New openings were punched into the eastern envelope to facilitate both daylighting and passive ventilation. These openings received casement windows for the same reasons listed above.
4. **Existing Windows with V-Cool Film Added:** Some of the windows in the building have been recently replaced. Rather than scrap these windows, we have proposed to add a film (see window information for more detail). This increases performance while keeping costs down.
5. **Existing Windows:** The windows on the northern façade of 317 Mulberry have been recently replaced. We have elected to keep these windows. (Northern windows would benefit little from an added film.)

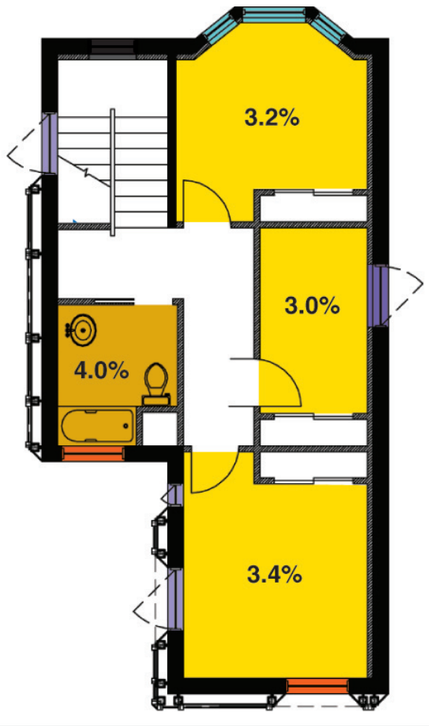
WINDOW TYPE LEGEND

- new double-hung windows
- new casement windows in new opening
- new casement windows
- existing windows with v-cool film added
- existing windows

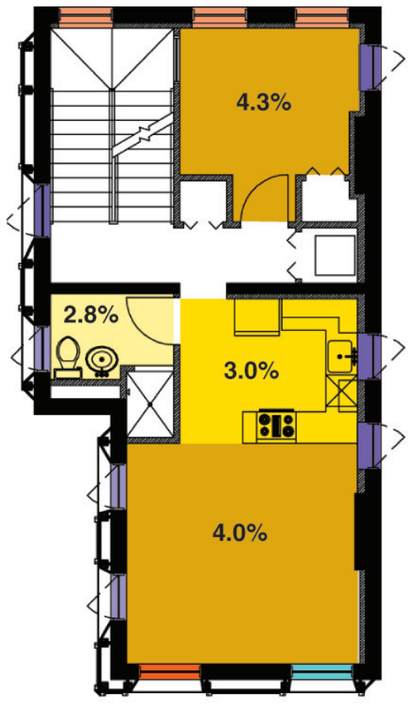
309: FIRST FLOOR (second fl. sim.)



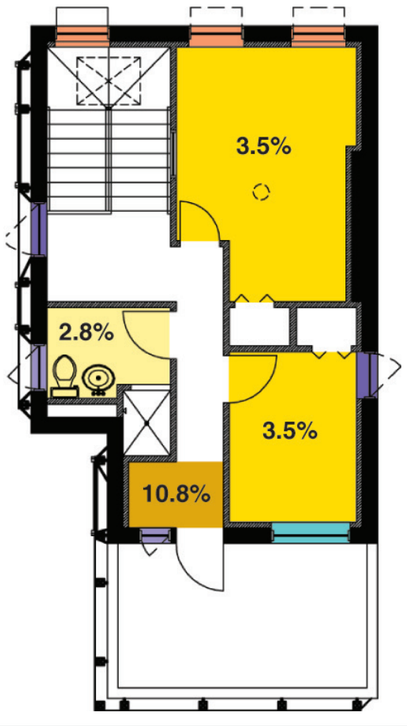
309: THIRD FLOOR



317: SECOND FLOOR (first fl. sim.)



317: FIRST FLOOR



DAYLIGHTING

DAYLIGHTING CALCULATIONS: 309 MULBERRY

Room	Floor Area	Glazing Area	Window Geometry		Transmittance (T^{vis})		Window Height	Daylight Factor		Daylit Area
	(SF)	(SF)	Type	Factor	Actual	Minimum	Factor	Each	Room	(SF)
First Floor:										
Bedroom	152								3.4%	152
		20	vision	0.1	0.6	0.4	0.8	1.6%		
		20	vision	0.1	0.5	0.4	0.8	1.3%		
		7.5	vision	0.1	0.5	0.4	0.8	0.5%		
Bathroom	112								2.1%	112
		20	vision	0.1	0.6	0.4	0.8	2.1%		
Kitchen	152								1.3%	
		20	vision	0.1	0.5	0.4	0.8	1.3%		
Living and Dining Room	256								2.3%	256
		20	vision	0.1	0.5	0.4	0.8	0.8%		
		20	vision	0.1	0.5	0.4	0.8	0.8%		
		20	vision	0.1	0.5	0.4	0.8	0.8%		
Second Floor:										
Dining Room	152								3.4%	152
		20	vision	0.1	0.6	0.4	0.8	1.6%		
		20	vision	0.1	0.5	0.4	0.8	1.3%		
		7.5	vision	0.1	0.5	0.4	0.8	0.5%		
Bathroom	60								4.0%	60
		20	vision	0.1	0.6	0.4	0.8	4.0%		
Kitchen	124								1.6%	
		20	vision	0.1	0.5	0.4	0.8	1.6%		
Living Room	215								2.1%	215
		15	vision	0.1	0.5	0.4	0.8	0.7%		
		15	vision	0.1	0.5	0.4	0.8	0.7%		
		15	vision	0.1	0.5	0.4	0.8	0.7%		
Third Floor:										
South Bedroom	153								3.4%	153
		20	vision	0.1	0.6	0.4	0.8	1.6%		
		20	vision	0.1	0.5	0.4	0.8	1.3%		
		7.5	vision	0.1	0.5	0.4	0.8	0.5%		
Bathroom	60								4.0%	60
		20	vision	0.1	0.6	0.4	0.8	4.0%		
East Bedroom	80								3.0%	80
		20	vision	0.1	0.6	0.4	0.8	3.0%		
North Bedroom	140								3.2%	140
		15	vision	0.1	0.5	0.4	0.8	1.1%		
		15	vision	0.1	0.5	0.4	0.8	1.1%		
		15	vision	0.1	0.5	0.4	0.8	1.1%		
Total	**1655**									**1379**
Percentage of Daylit Area:										**83%**

Sourcces: (1) LEED v 2.1, (2) Mechanical and Electrical Equipment for Buildings, 10th ed., by Benjamin Stein, et al. (2006)

DAYLIGHTING

DAYLIGHTING CALCULATIONS: 317 MULBERRY

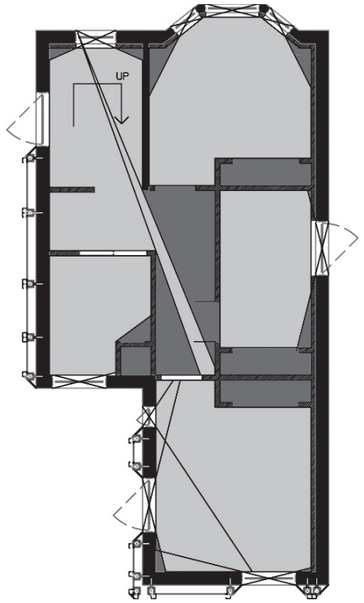
Room	Floor Area (SF)	Glazing Area (SF)	Window Geometry Type	Window Geometry Factor	Transmittance (Tvis) Actual	Transmittance (Tvis) Minimum	Window Height Factor	Daylight Factor Each	Daylight Factor Room	Daylit Area (SF)
Basement:										
South Bedroom	131								2.5%	131
		15	vision	0.1	0.6	0.4	0.8	1.4%		
		15	vision	0.1	0.5	0.4	0.8	1.1%		
Bathroom	53								2.8%	53
		15	vision	0.1	0.5	0.4	0.8	2.8%		
East Bedroom	89								3.4%	89
		15	vision	0.1	0.5	0.4	0.8	1.7%		
		15	vision	0.1	0.5	0.4	0.8	1.7%		
First Floor:										
Living and Dining Room	205								4.0%	205
		15	vision	0.1	0.5	0.4	0.8	0.7%		
		15	vision	0.1	0.5	0.4	0.8	0.7%		
		20	vision	0.1	0.6	0.4	0.8	1.2%		
		20	vision	0.1	0.5	0.4	0.8	1.0%		
		7.5	vision	0.1	0.5	0.4	0.8	0.4%		
Bathroom	53								2.8%	53
		15	vision	0.1	0.5	0.4	0.8	2.8%		
Kitchen	101								2.2%	101
		15	vision	0.1	0.5	0.4	0.8	1.5%		
		7.5	vision	0.1	0.5	0.4	0.8	0.7%		
North Bedroom	159								4.3%	159
		17	vision	0.1	0.8	0.4	0.8	1.7%		
		17	vision	0.1	0.8	0.4	0.8	1.7%		
		15	vision	0.1	0.5	0.4	0.8	0.9%		

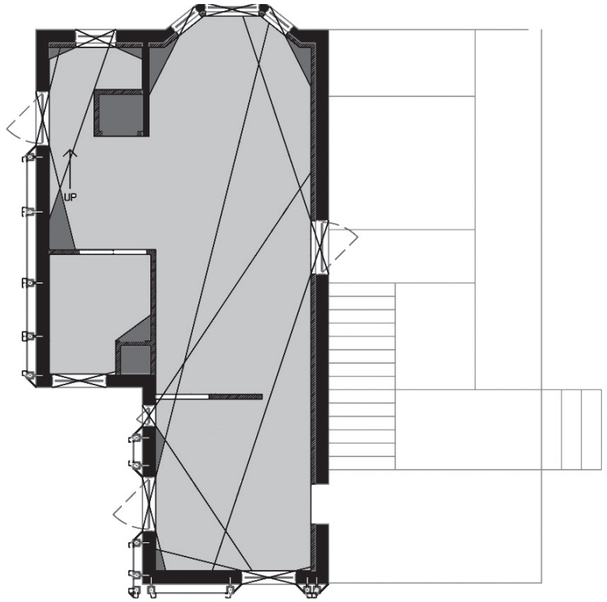
Room	Floor Area (SF)	Glazing Area (SF)	Window Geometry Type	Window Geometry Factor	Transmittance (Tvis) Actual	Transmittance (Tvis) Minimum	Window Height Factor	Daylight Factor Each	Daylight Factor Room	Daylit Area (SF)
Second Floor:										
Living and Dining Room	205								4.0%	205
		15	vision	0.1	0.5	0.4	0.8	0.7%		
		15	vision	0.1	0.5	0.4	0.8	0.7%		
		20	vision	0.1	0.6	0.4	0.8	1.2%		
		20	vision	0.1	0.5	0.4	0.8	1.0%		
		7.5	vision	0.1	0.5	0.4	0.8	0.4%		
Bathroom	53								2.8%	53
		15	vision	0.1	0.5	0.4	0.8	2.8%		
Kitchen	101								3.0%	101
		15	vision	0.1	0.5	0.4	0.8	1.5%		
		15	vision	0.1	0.5	0.4	0.8	1.5%		
Bedroom	159								4.3%	159
		17	vision	0.1	0.8	0.4	0.8	1.7%		
		17	vision	0.1	0.8	0.4	0.8	1.7%		
		15	vision	0.1	0.5	0.4	0.8	0.9%		
Third Floor:										
Study Nook	24								10.8%	24
		15	vision	0.1	0.5	0.4	0.8	6.3%		
		11	vision	0.1	0.5	0.4	0.8	4.6%		
Bathroom	53								2.8%	53
		15	vision	0.1	0.5	0.4	0.8	2.8%		
South Bedroom	87								3.5%	87
		15	vision	0.1	0.5	0.4	0.8	1.7%		
		15	vision	0.1	0.5	0.4	0.8	1.7%		
North Bedroom	162								3.5%	162
		17	vision	0.1	0.8	0.4	0.8	1.6%		
		17	vision	0.1	0.8	0.4	0.8	1.6%		
		1.3	vision	0.1	1	0.4	0.8	0.2%		
Total	**1309**									**1309**
Percentage of Daylit Area:										**100%**

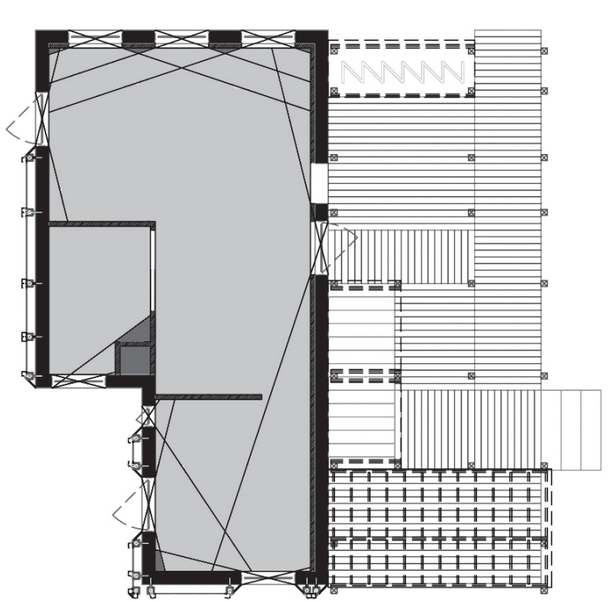
Sourcces: (1) LEED v 2.1, (2) Mechanical and Electrical Equipment for Buildings, 10th ed., by Benjamin Stein, et al. (2006)

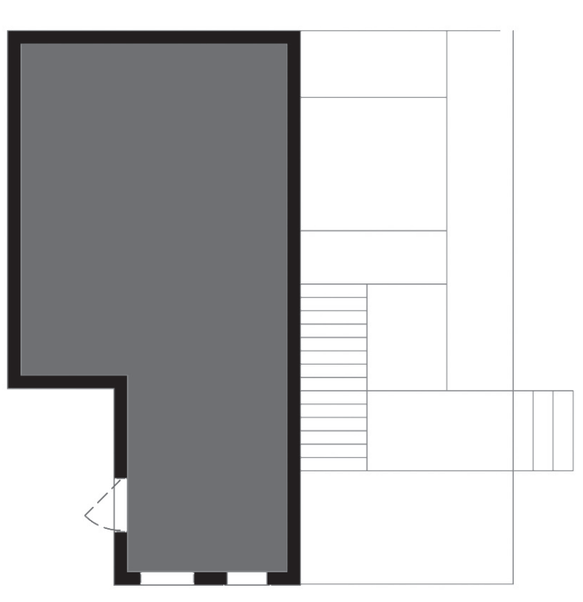
VIEWS

VIEWS: 309 MULBERRY









VIEW LEGEND

exterior views

no exterior views

EXTERIOR VIEWS: 309

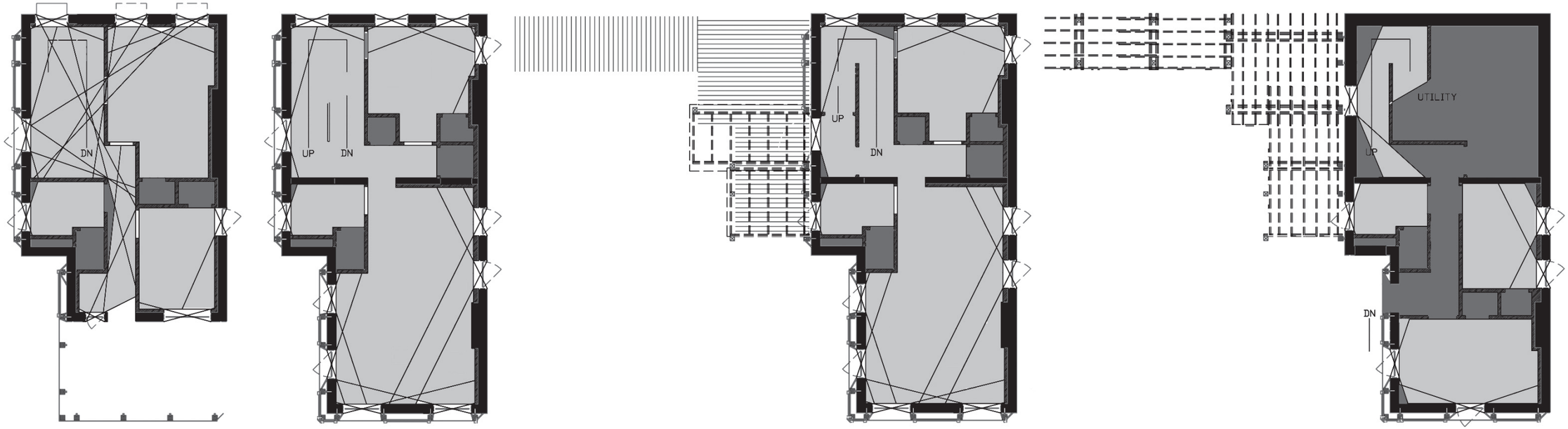
Because of the open floor plans and the abundance of windows, exterior views are available to nearly all interior spaces. In fact, the only spaces lacking views are hallways and closets.

The basement has some exterior views but is not a regularly occupied space.

The abundance of exterior views qualifies this design for LEED Credit 8.2: Daylight and Views, Views for 90% of Spaces.

VIEWS

VIEWS: 317 MULBERRY



VIEW LEGEND

exterior views

no exterior views

EXTERIOR VIEWS: 317

Because of the open floor plans and the abundance of windows, exterior views are available to nearly all interior spaces. In fact, the only spaces lacking views are closets.

The abundance of exterior views qualifies this design for LEED Credit 8.2: Daylight and Views, Views for 90% of Spaces.

TROMBE WALL

WHAT IT IS:
A trombe wall is a passive solar collector that can help to heat the house. It consists of glazing, an air space, and thermal mass. The sun shines through the glazing and warms up the air space and the thermal mass. This heat transfer slowly passes through into the building, and the time delay makes the system particularly effective for heating at night.

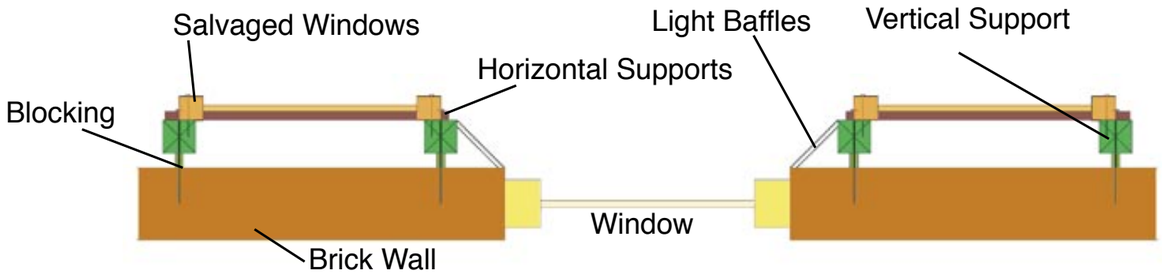
HOW WE ARE USING IT:
On our house, the trombe wall system is made from salvaged windows and a wood framing system. It faces south to take most advantage of the solar gain, but also faces west to take advantage of the afternoon sun. It is part of a grid skin system that envelopes the whole house.

IN THE WINTER:
The deciduous trees to the south will lose thier leaves and allow more sun to penetrate through the branches to the southern facade. This will allow for more heat gain in the winter when the most heating is needed.

IN THE SUMMER:
Because in the summer, heating is not a primary goal, the trombe wall needs to be shaded and vented to prevent excess warmth from being absorbed. The deciduous trees to the south will help to naturally shade the southern facade of the trombe wall and protect it from overheating. The western facade will also be slightly shaded by these trees. In addition to the shading provided by the trees, a ventilation system will be used on the trombe wall. By opening ventilation flaps along the top and bottom edges of the trombe wall, air flow will be able to move between the air space. The hot air will be pulled out of the top of the trombe wall by any air passing over the ventilation flap, and cool air will be pulled into the bottom of the trombe wall.

317 PERSPECTIVE

Trombe Wall



CONSTRUCTION NOTES -
6”x6” posts will be used for the vertical members. These will also be used on the deck to minimize scrap and provide unity to the facade. The wood should not be pressure treated, as this process involves a large amount of chemicals, which eventually return to the earth as the wood is rained on and drains. They should be painted with the low VOC exterior paint mentioned in the materials list.

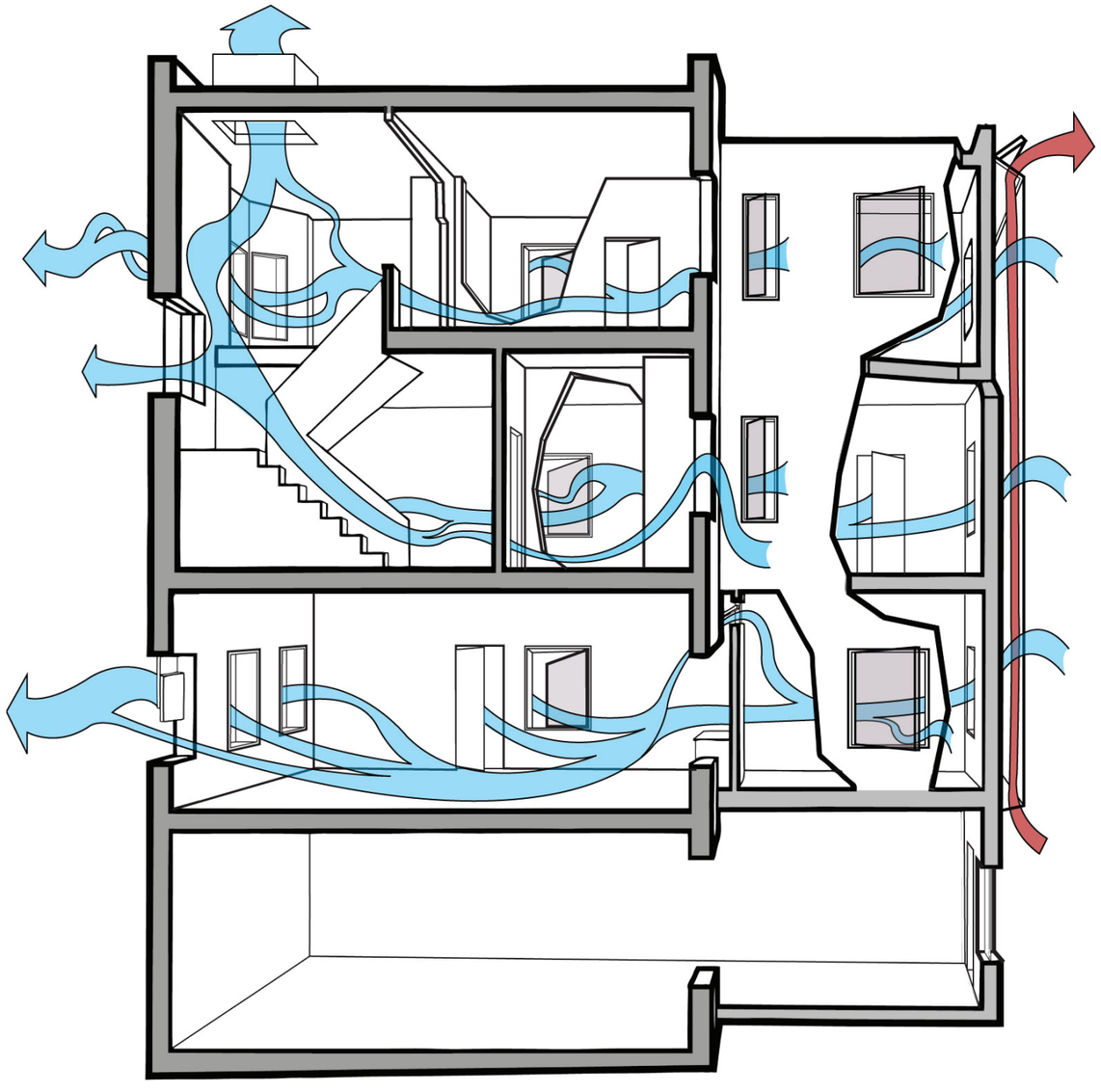
Horizontal members will be bolted to vertical posts. These will then be bolted to the brick for stabilization with blocking behind the members to reach the wall. These bolts will occur infrequently to eliminate damage to the wall. They are only used for stabilization against wind loads, not for structure.

WINDOWS:
We estimate each window being about $25-40 from the Cincinnati Salvage store. With each window being an average dimension of 3’ x 4’ , we estimate a need of 70 windows. Therefore the total cost of windows would be roughly between $175 and $280. These windows will be single paned fixed windows, thereby letting more light into the trombe wall, thus letting more heat enter the trombe wall. Because the windows are salvaged, they will have different frames. We plan on painting them to bring coherence to the structure.

BAFFLES:
The baffles are made of 3/8” white painted wood, and are used to connect existing windows to the trombe wall system. They allow for the inhabitants to continue use of their windows without hindering the trombe wall. They are painted white to reflect more light into the space, helping to daylight the interior.

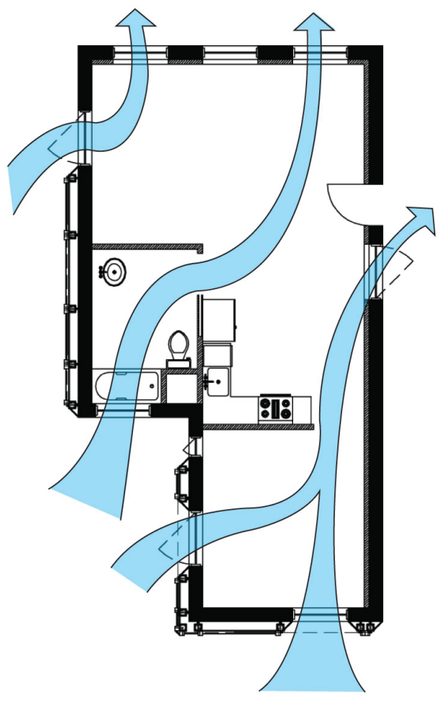
VENTING MECHANISM-
The vents at the top and bottom of the trombe wall are made of 1/2” painted wood. They will have hinges for ease of use. The inhabitants should open the bottom and top vents when they do not want the house heated. The lower ones are easily accessed from outside at ground or deck level. The upper ones must be accessed from the roof or roof patio.

PASSIVE VENTILATION

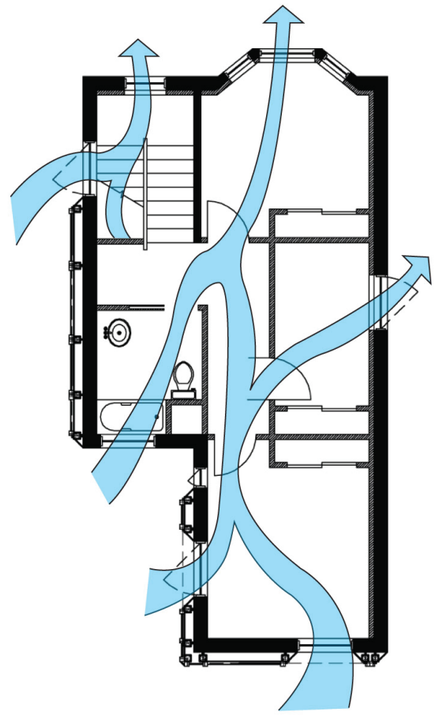


309 MULBERRY PASSIVE VENTILATION

In our experiment with wind movements through the house, we found that the stack effect created in the northwest corner was very effective. The vent at the top should be painted black to heat up the air, thus drawing cool air from below upward to cool down the upper floor. Before punching windows in the east wall, air pooled in the back of the building on the lower floors. With the new window, and the potential for a screen in the

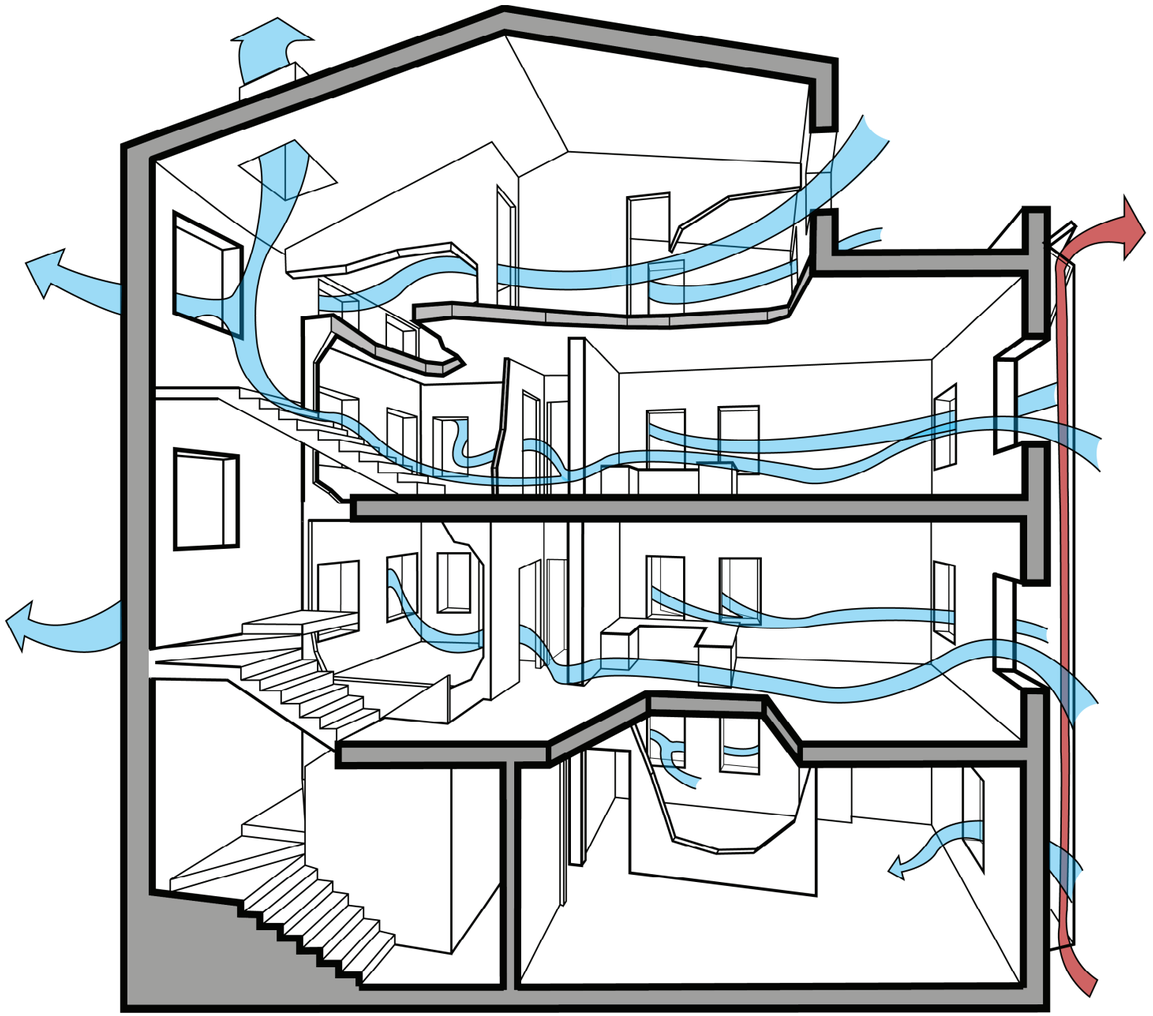


1ST FLOOR PASSIVE VENTILATION

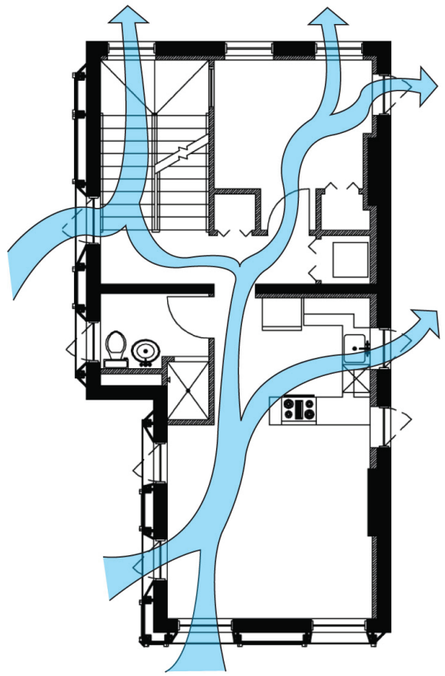


3RD FLOOR PASSIVE VENTILATION

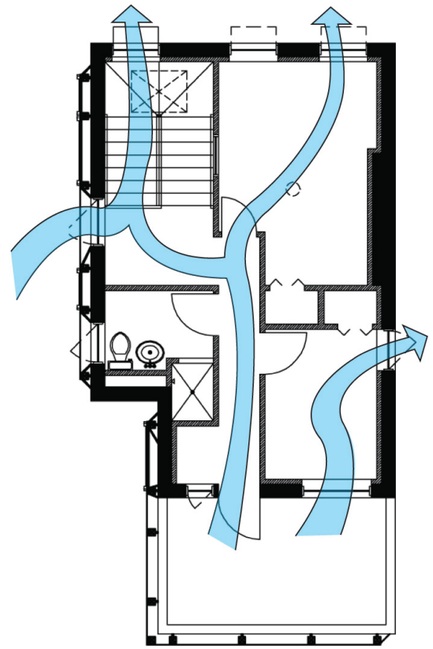
PASSIVE VENTILATION



317 MULBERRY PASSIVE VENTILATION
The stairs on the northwest corner again create a stack effect.



2ND FLOOR PASSIVE VENTILATION



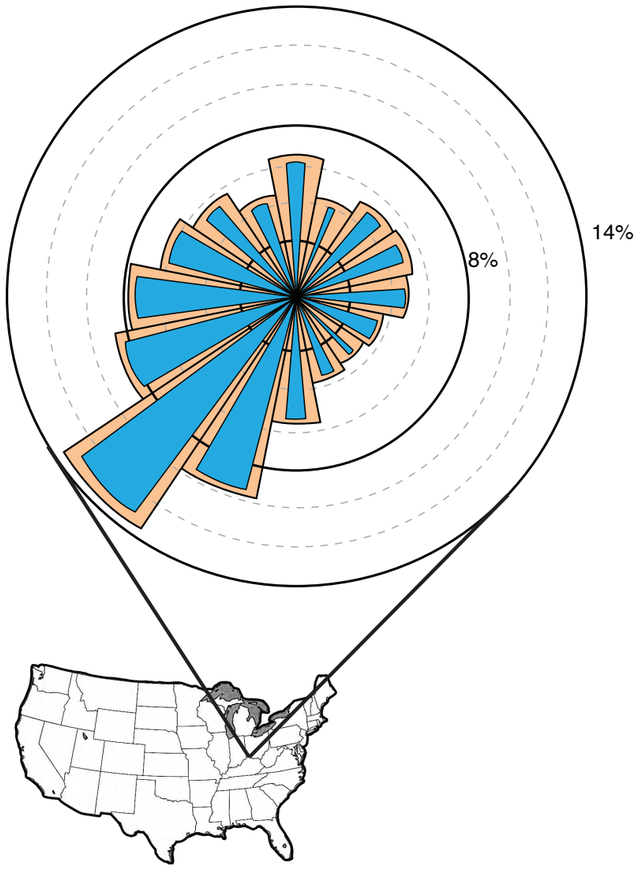
3RD FLOOR PASSIVE VENTILATION

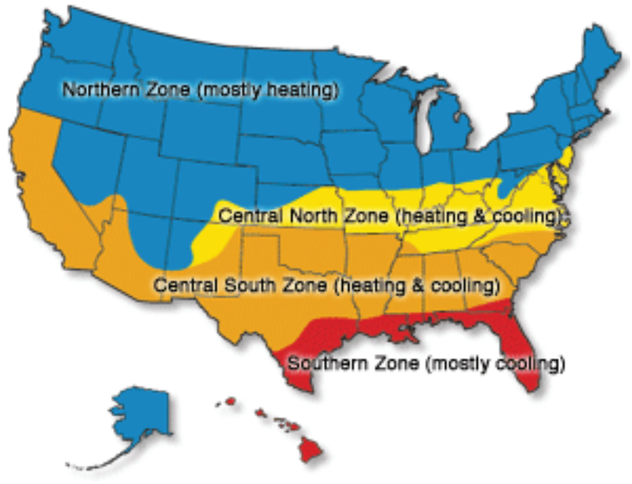
Passive Ventilation

WIND DIRECTION:
A Wind Rose Measures the velocity, frequency and direction from which the wind blows in a particular geographic region. The wind is measured from sixteen different directions and charted on a graph to show the percentage of time and intensity that the wind is blowing from a particular bearing.

For the Cincinnati region, wind measurements are taken from the Greater CIncinnati and Northern Kentucky International Airport, KY. These are the averaged wind velocities and direction from April 1st-October 31st over a four year period from 1988-1992. The prevailing wind came from the Southwest 14% of the time with a top velocity of 21+ knots.

This information has guided our investigation of the ventilation patterns through the houses.





NORTH/CENTRAL HEATING AND COOLING ZONE
This area of the country is characterized by moderately hot summers and cold winters. Windows in this area should be rated to screen a portion of the sun's heat. This keeps the home cooler in the summer while also admitting a good amount of solar heat during the winter months.

SOLAR HEAT GAIN COEFFICIENT:
The SHGC is a fraction of the incident solar radiation admitted through a window, both directly transmitted, and absorbed and subsequently released inward. The SHGC is shown as a decimal between 0 and 1, where lower means less solar heat transmittance.

Windows
SHGC=0.55 or less

Skylights
SHGC=0.40 or less

U-FACTOR:
The rate of heat loss is measured in terms of the U-factor or U-value. This is the inverse of the R-value, which is the insulating value. The lower the U-value, the greater a window's resistance to heat flow and the better its insulating value.

For this climate zone, we should be using about U=0.32 for the windows. On skylights, U=0.60 or less for skylights oriented below 20 degrees. On those up to 90 degrees, 0.45 is a good U-value.

AIR LEAKAGE
An air leakage rating (AL) expresses the equivalent cubic feet of air passing through a square foot of window area. Lower AL values mean less air will pass through cracks in the window assembly. At this time, the Al is optional.

No requirements, though 0.30 is recommended

VISIBLE TRANSMITTANCE:
The VT is the amount of light which is transmitted, including the frame area, where none enters. It should be between 0 and 1, most commonly between .3 and .8. Higher numbers mean more light is transmitted, a desirable quality for daylighting.

There are no requirements in our area for Visible Transmittance

www.epa.gov/ttn/naaqs/ozone/areas/wind.htm; www.efficient windows.org; Lechner

Window Strategies and Advantages

AMERICAN STANDARD SERIES 7500 CASEMENT WINDOWS

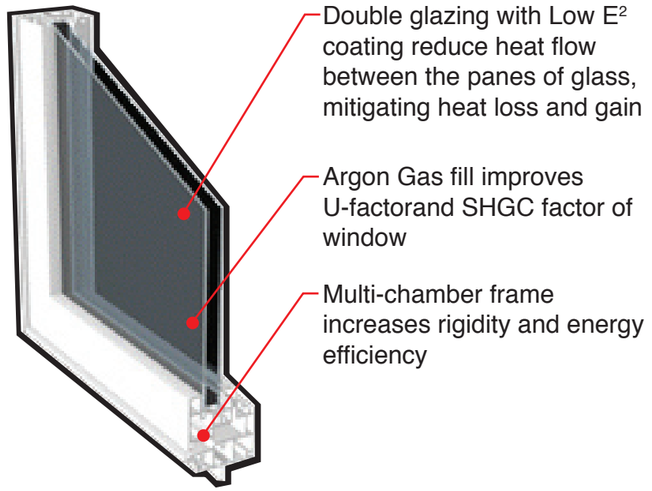
-Can be found at any local Home Depot store
-Easy for customer or professional installation

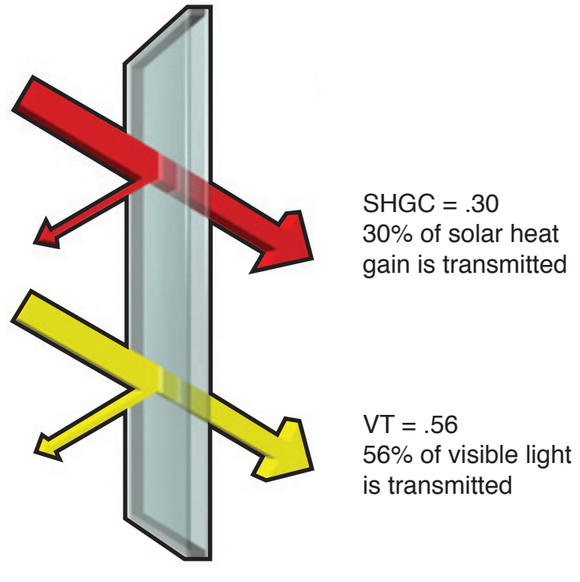
ENERGYSTAR CERTIFIED

-More efficient windows help keep heat in during the winter months and keep the heat out during the summer months.
-Certified for the North/Central Climate Zone
-Window opening is 90% of total space

WINDOW RATINGS AND FACTORS

-U-Factor= 0.32
-Solar Heat Gain Coefficient (SHGC)= 0.30
-Air Infiltration= 0.1
-Visible Transmittance Level= 0.56
-Forced Entry Resistant

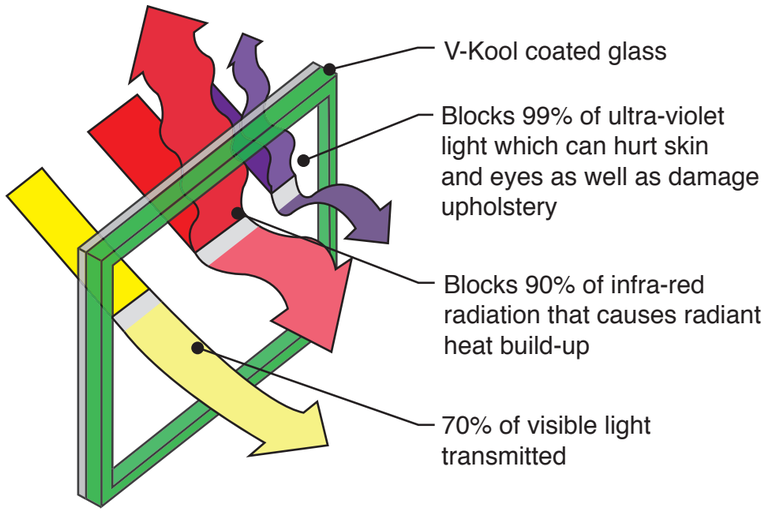


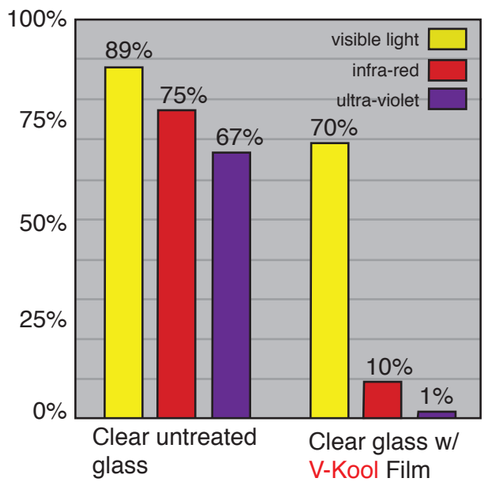


V-KOOL WINDOW FILM

-After market clear film that reduces penetration of infra-red and ultra-violet light rays while allowing in a maximum of natural light
-Applied to existing windows on South and West facades
-Cost is $5.00 per square foot including labor
-Keeps heat out during summer months allowing passive systems to more efficiently cool the homes

www.efficientwindows.org, www.energystar.gov, www.v-kool.com, www.americancraftsmanwin.com

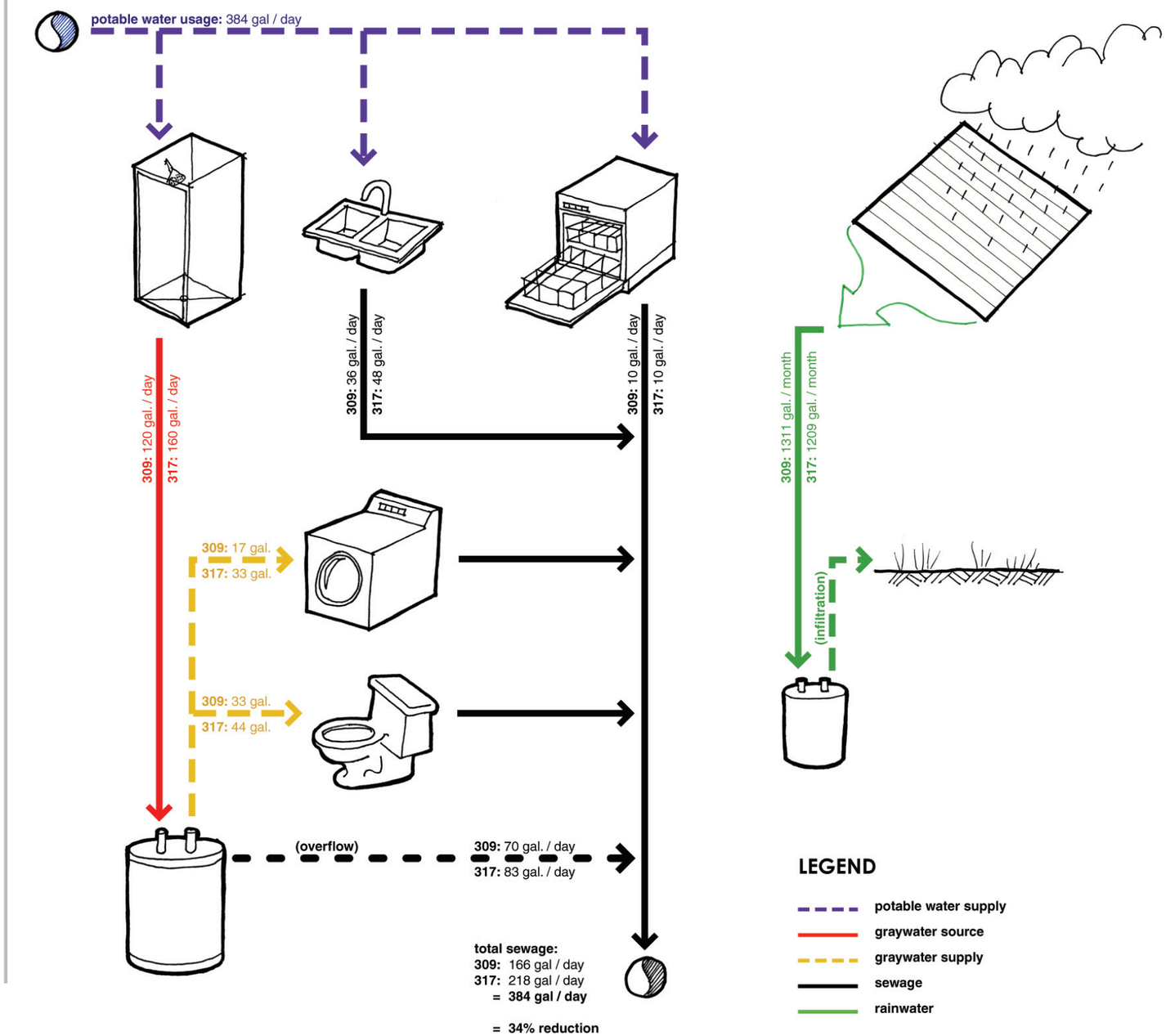




Transmittance Levels

The Greywater System

WATER FLOWS & USAGE



WATER FLOW AND USAGE:

According to LEED: “Conventional wastewater systems require significant volumes of potable water to convey waste to municipal wastewater treatment facilities. However, greywater sources can be substituted for potable water to flush toilets and urinals” (LEED 2.1, 92).

In this development, water from showers is filtered and used in washing machines and toilets. Combined with the specification of water-efficient appliances and low-flow fixtures, these design features result in an overall water use reduction of 31% for 309 and 36% for 317.

Greywater can also be collected from sinks, dishwashers, and washing machines. This was not done for two reasons: (1) such a move would result in a excess of graywater and not enough places to use it (see calculations), and (2) water from the shower is the highest quality (as greywater goes) and requires the least filtering in order to be reused. This means less equipment and lower costs.

Additionally, water is collected from the roof and stored in cisterns where it is released slowly into the site. This move (1) reduces the amount of stormwater going into the municipal stormwater system, and (2) mitigates the danger of erosion caused by rapidly flowing water from downspouts. This system is entirely separate from the graywater system of the apartment units.

The Greywater System

LEGEND

potable water sup
graywater source
graywater supply
sewage

DUAL PIPE SYSTEM:

In order to achieve the graywater flows listed above, a two-pipe system is required: one pair for the conventional potable water and sewage lines, and a second set for the proposed greywater collection and distribution. The diagrams (to the right) show the locations of this plumbing. Aligning the plumbing on each floor minimizes the amount of piping and the complexity of the plumbing, thus minimizing overall costs for a system that is typically more expensive.

BLACKWATER TREATMENT

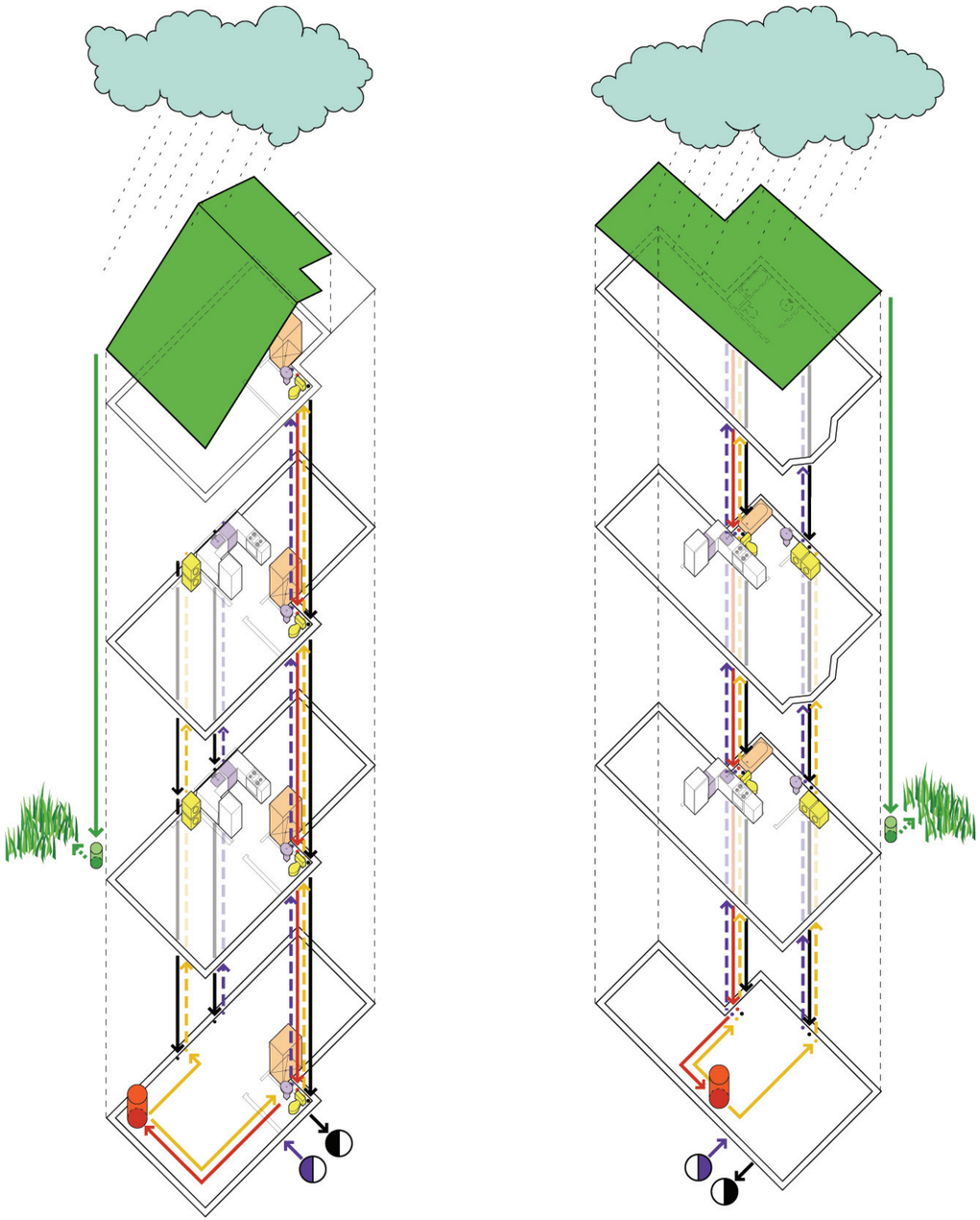
On-site treatment of blackwater (i.e., sewage water) was considered for this project. The benefits of blackwater treatment are (1) 100% reduction sewage conveyed to municipal facilities, and (2) corresponding LEED points (Water Efficiency Credit 2: Innovative Wastewater Technologies).

A blackwater system would most likely consist of a Living Machine—a series of gardens and wetlands that naturally remove contaminants. A single Living Machine would serve both buildings, and would have mostly likely been located in the “ravine” of the condemned street as a series of greenhouses and terraced beds. Gravity would move the water through these beds.

This solution does not appear in the proposal for several reasons:

1. The slope of the site made the design of such a system difficult. The required terracing would be intensive and costly.
2. The purified water would be released at the end of the Living Machine, most likely into a wetland at the bottom of the hill that would provide slow infiltration into the ground. This would require either the purchase of additional property at the bottom of the hill, or allowing the flow of sewage water (albeit purified sewage water) across other properties, which raised legal questions.
3. The legality of such a system was uncertain. For example, a Living Machine in Beria, Kentucky is not used to purify blackwater because the municipal government will not approve it. This is result of political reticence and red tape rather than concern about safety or health issues (Living Machines have been shown to provide an extremely high level of purification); but the end result is the disuse of an expensive system.
4. The system requires maintenance, responsibility for which would have to be communal.

However, if poltical will and financing permit, blackwater treatment should certainly be reconsidered—especially if this project is conceived as a demonstration of sustainable practices.



GREYWATER CALCULATIONS: 309 MULBERRY: DESIGN CASE

Graywater Generated

Fixture Type	Daily Uses	Flowrate (GPF)	Total Daily Per Person	Occupants	Graywater (gal)	Sewage Generation (gal)
Low-Flow Shower			20	6	120	
			Total Daily Volume (gal)		120	
			Annual Days		365	
			Annual Volume (gal)		**43800**	

Graywater Used

Fixture Type	Daily Uses	Flowrate (GPF)	Total Daily Per Person	Occupants	Graywater (gal)	Sewage Generation (gal)
Low-Flow Water Closet	5	1.1	5.50	6	-33.00	
Front Load Washer -						
Adult: 1.5 loads per week			2.14	3	-6.43	
Child: 2.5 loads per week			3.57	3	-10.71	
			Total Daily Volume (gal)		-50.14	
			Annual Days		365.00	
			Annual Volume (gal)		**-18302.14**	

Sewage Generated

Fixture Type	Daily Uses	Flowrate (GPF)	Total Daily Per Person	Occupants	Graywater (gal)	Sewage Generation (gal)
Greywater Unused						69.86
Kitchen Sink			5	6		30
Dishwasher	2	5				10
Bathroom Sink			1	6		6
Low-Flow Water Closet	5	1.1	5.50	6		33
Front Load Washer -						
Adult - 1.5 per Week			2.14	3		6.43
Child - 2.5 per Week			3.57	3		10.71
			Total Daily Volume (gal)			166.00
			Annual Days			365
			Annual Volume (gal)			**60590.00**

Rainwater Collected

Collection Area (SF)	Collection Efficiency (%)	Average Monthly Rainfall (in)	0.6233 gal/in	Rainwater Volume (gal per month)
797	80%	3.2983333	0.6233	1310.81

GREYWATER CALCULATIONS: 309 MULBERRY: BASELINE CASE

Sewage Generated

Fixture Type	Daily Uses	Flowrate (GPF)	Total Daily Per Person	Occupants	Sewage Generation (gal)
Conventional Shower			40	6	240
Kitchen Sink			15	6	90
Dishwasher	2	10			20
Bathroom Sink			5	6	30
Conventional Water Closet	5	1.6	8.00	6	48
Top Load Washer -					
Adult: 1.5 loads per week			6.43	3	19.29
Child: 2.5 loads per week			10.71	3	32.14
			Total Daily Volume (gal)		239.43
			Annual Days		365
			Annual Volume (gal)		**87391.43**

Baseline Volume	87391.43
Design Volume	-60590.00
Reduction Volume	26801.43

Reduction Volume	26801.43
Baseline Volume	87391.43
Sewage Reduction	**31%**

Sourcces: (1) LEED v 2.1, (2) Mechanical and Electrical Equipment for Buildings, 10th ed., by Benjamin Stein, et al. (2006)

GREYWATER CALCULATIONS: 317 MULBERRY: DESIGN CASE

Graywater Generated

Fixture Type	Daily Uses	Flowrate (GPF)	Total Daily Per Person	Occupants	Graywater (gal)	Sewage Generation (gal)
Low-Flow Shower			20	8	160	
			Total Daily Volume (gal)		160	
			Annual Days		365	
			Annual Volume (gal)		**58400**	

Graywater Used

Fixture Type	Daily Uses	Flowrate (GPF)	Total Daily Per Person	Occupants	Graywater (gal)	Sewage Generation (gal)
Low-Flow Water Closet	5	1.1	5.50	8	-44.00	
Front Load Washer -						
Adult: 1.5 loads per week			2.14	2	-4.29	
Child: 2.5 loads per week			3.57	8	-28.57	
			Total Daily Volume (gal)		-76.86	
			Annual Days		365.00	
			Annual Volume (gal)		**-28052.86**	

Sewage Generated

Fixture Type	Daily Uses	Flowrate (GPF)	Total Daily Per Person	Occupants	Graywater (gal)	Sewage Generation (gal)
Greywater Unused						83.14
Kitchen Sink			5	8		40
Dishwasher	2	5				10
Bathroom Sink			1	8		8
Low-Flow Water Closet	5	1.1	5.50	8		44
Front Load Washer -						
Adult - 1.5 per Week			2.14	2		4.29
Child - 2.5 per Week			3.57	8		28.57
			Total Daily Volume (gal)			218.00
			Annual Days			365
			Annual Volume (gal)			**79570.00**

Rainwater Collected

Collection Area (SF)	Collection Efficiency (%)	Average Monthly Rainfall (in)	0.6233 gal/in	Rainwater Volume (gal per month)
735	80%	3.2983333	0.6233	1208.84

GREYWATER CALCULATIONS: 317 MULBERRY: BASELINE CASE

Sewage Generated

Fixture Type	Daily Uses	Flowrate (GPF)	Total Daily Per Person	Occupants	Sewage Generation (gal)
Conventional Shower			40	8	320
Kitchen Sink			15	8	120
Dishwasher	2	10			20
Bathroom Sink			5	8	40
Conventional Water Closet	5	1.6	8.00	8	64
Top Load Washer -					
Adult: 1.5 loads per week			6.43	2	12.86
Child: 2.5 loads per week			10.71	8	85.71
			Total Daily Volume (gal)		342.57
			Annual Days		365
			Annual Volume (gal)		**125038.57**

Baseline Volume	125038.57
Design Volume	-79570.00
Reduction Volume	45468.57

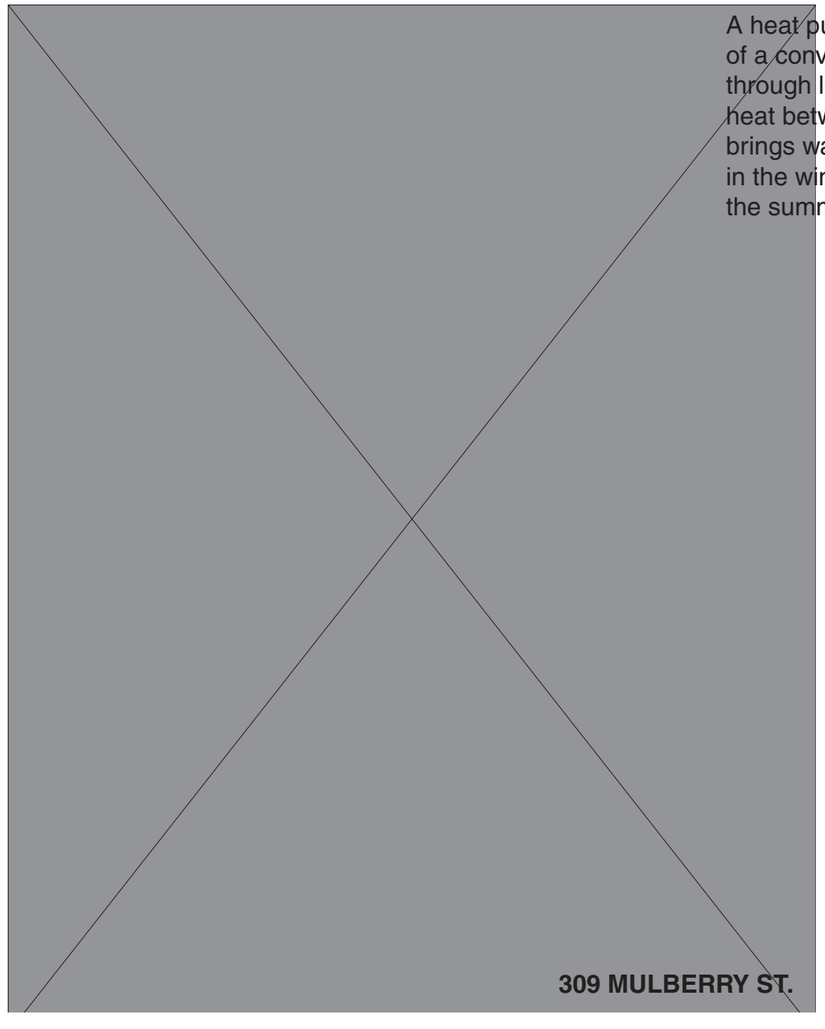
Reduction Volume	45468.57
Baseline Volume	125038.57
Sewage Reduction	**36%**

Sourcces: (1) LEED v 2.1, (2) Mechanical and Electrical Equipment for Buildings, 10th ed., by Benjamin Stein, et al. (2006)

THE GEOEXCHANGE SYSTEM

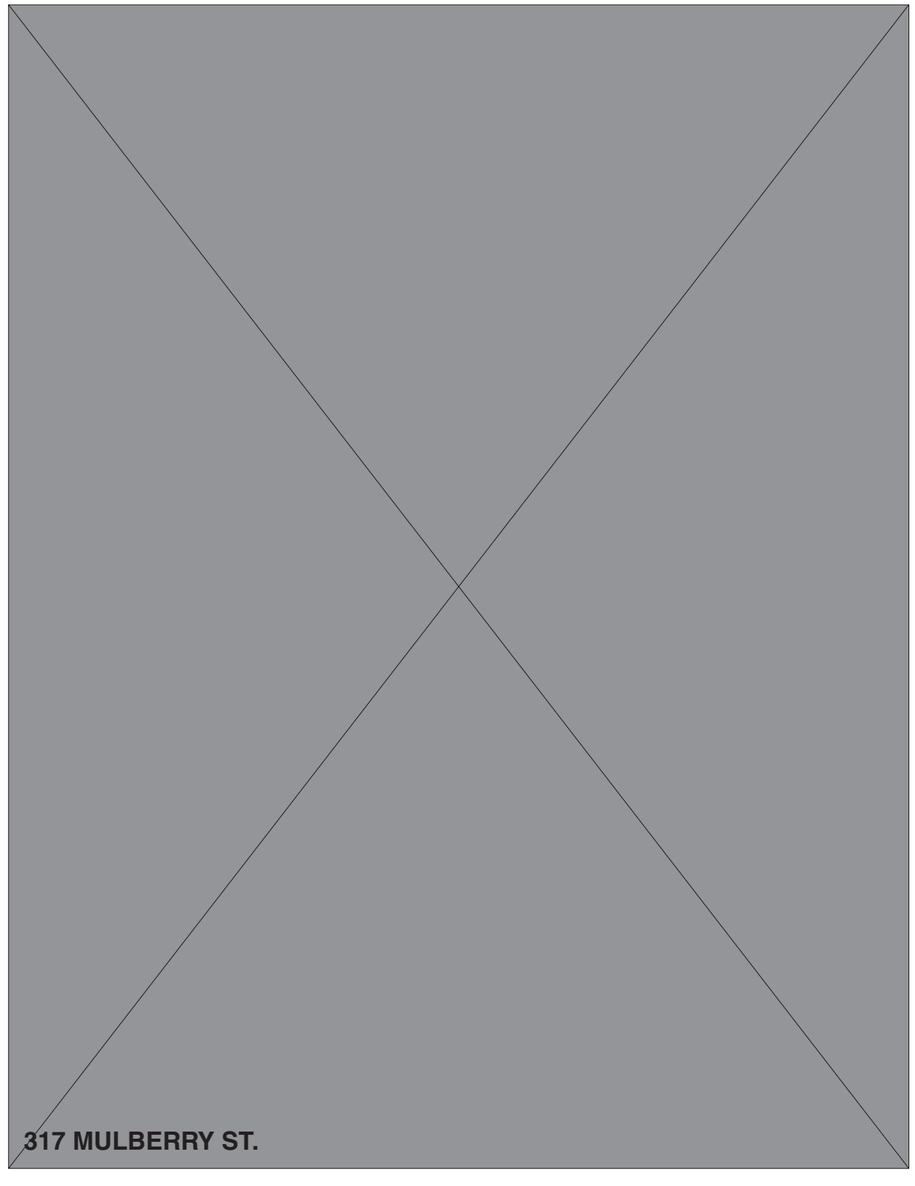
HOW IT WORKS:

Geoexchange relies on thermal mass and temperature diferences to heat and cool a building. Because the earth beneath a building has much more thermal mass than the surrounding air, it heats up and cools down at a much slower speed. This makes its temperature fluctuation much less dramatic than that of the surrounding air temperature. The ground temperature is more constant throughout the seasons and in the winter, the soil helps to heat the house, while in the summer, it helps to cool the house.



309 MULBERRY ST.

A heat pump in the basement, roughly the size of a conventional furnace, moves antifreeze through loops in the ground, transferring the heat between the house and the tubes. This brings warmth from the ground into the house in the winter, and expels it from the house in the summer to be absorbed by the earth.

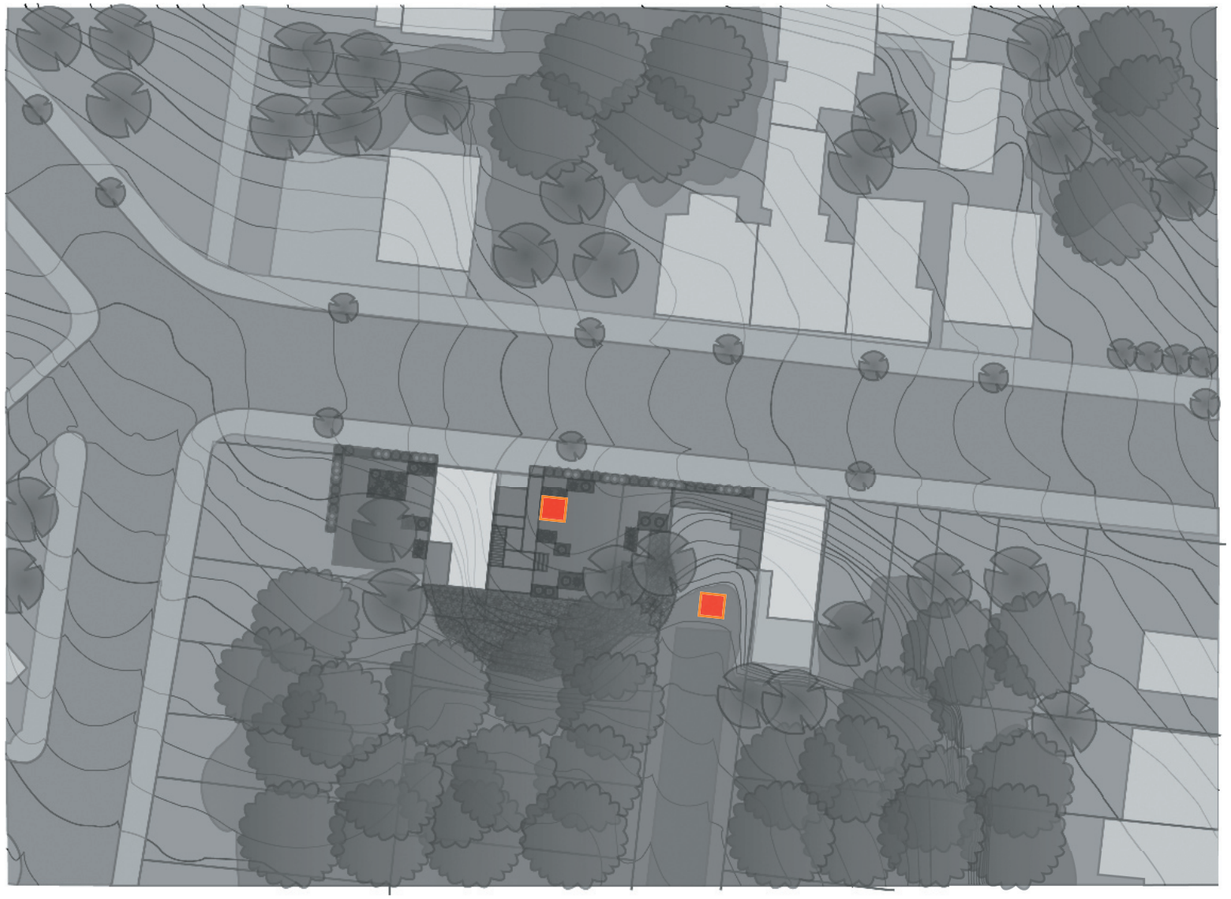


317 MULBERRY ST.

The Geoexchange System

OUR SITUATION:
The composition of our soil is 54" of urban pate, which is a soft soil, and below that is solid bedrock. Each house is approximately 2000 square feet. Heating and air conditioning loads are generally 1 ton per 650-750 square feet. Therefore, each house requires 3 to 3.5 tons.

THE SYSTEM:
Vertical system of tubes would be employed because of the steep slope and quality of soil. A horizontal system would not be effective due to the shallow bedrock. The tubes would run into these rock walls, and then the system would have to make a turn, quickly taking up more space than that available.



0' 100'

GEOEXCHANGE LOCATIONS

N

THE HOLES:
3 holes necessary, at 205' deep
20-25' away from house
20'x20' area necessary for holes + ditches
for connections to house

SYSTEM COSTS:
Drilling Cost: $4,600 (included in total price)
Total Price: $3800 to 4000 per ton
Our houses: 2000 sf=3 to 3.5 tons
Total: $13,000-$15,000 for our system

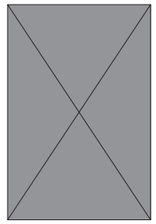
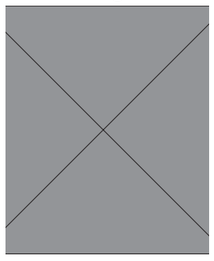
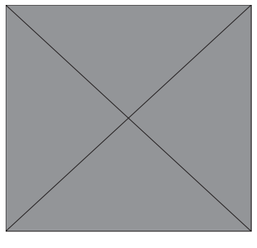
INCLUDED IN TOTAL PRICE:
Excavation
Connections between holes
Connection to house
Connection of pump and ducts
Flushing the tubes
Filling the holes
Adding the liquid
Desuper Heater Kit
(EVERYTHING FOR INSTALLATION)

OPERATION SAVINGS:
Between 50 and 60% less than
forced air system

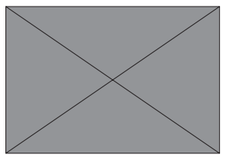
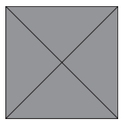
WAYS OF REDUCING COSTS:
Lower heat gain--shading
Cut down run time
Trombe wall (helps only for heating)
Solar assistance--solar cells heat water going to unit. (very costly in and of themselves) make 55o water increase to 65-70o

DESUPER HEATER KIT (INCLUDED IN PRICE)
This auxilliary part takes gas off of the compressor and uses it to heat water. In the summer, this creates no disadvantage within the entire system, but in the winter, the heat used by this system would normally be used for heating the spaces. This addition can save several hundred dollars per year and is included in the installation price.

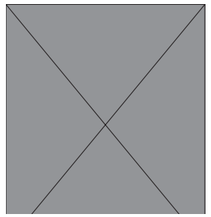
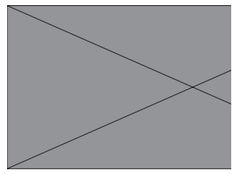
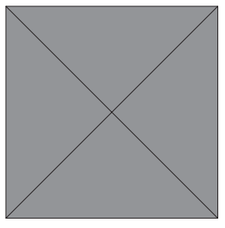
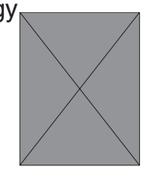
Materials and Equipment

MATERIAL	USED FOR	UNIT COST	AMOUNT	LOCAL DEALER	SPECS/SIZE	BENEFITS	PAY BACK TIME
American Standard Casement Windows 	New East and West Windows	$200 $228	309--3 317--0 309--9 317--20	Home Depot Store	15” x 60” 32” x 60”	Low E Glazing and Argon Gas filled make windows more energy efficient Casement style allows for better cross ventilation (90% opens compared to 45% for double-hung)	For adding Argon Gas: 309--1.8 Years 317--1.1 Years $5.80 per window cost Case study shows gas save $65 per year on energy bill
Double Hung Window 	Replacement on north and south	$285	309--9 317--3	Home Depot Store	38” x 60”	Low E Glazing and Argon Gas filled make windows more energy efficient	
V-Kool Glazing Film 	Used to make the south windows more energy efficient	$5 per sq. ft.	309--120 sq. ft. 317--60 sq. ft.	Westland Tech Center 13805 West Road Suite 400 Houston, Texas 77041		Allows up to 70% of visible light to pass while blocking 90% infrared and 99% of ultraviolet light	
Salvaged Windows	Trombe Wall	$25	309--35 317--35	Building Value LLC (The Salvage Store) 2901 Gilbert Ave. Cincinnati, OH	3’ x 5’	Reusing old materials	

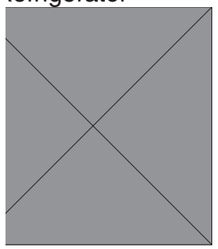
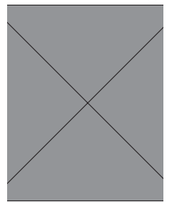
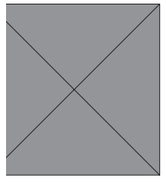
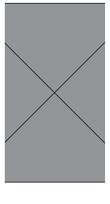
Materials and Equipment

MATERIAL	USED FOR	UNIT COST	AMOUNT	LOCAL DEALER	SPECS/SIZE	BENEFITS	PAY BACK TIME
Composite Decking	Porches	12 ft.-- $22 16 ft.-- $29	309--34 317--43 309--44 317--12	Lowes	2” x 6” x 12’ 2” x 6” x 16’	Uses recycle materials Lasts a long time, Maintenance free	
Fiberock Aqua Tough Interior Recycled Gypsum Drywall 	Adding Insulation to East and North walls		309--1800 sq. ft. 317--2100 sq. ft..	USG Sales Rep. Lynn Rhow Carmel, IN 317-848-1515 www.usg.com	4’ x 8’ sheets	Made from 95% recycled materials such as newspaper and gypsum from titanium dioxide production Panels are moisture, mold and fire resistant	
Ultra Touch Natural Cotton Fiber Insulation 	Adding Insulation to East and North walls	$0.55 sq. ft.	309--1800 sq. ft. 317--2100 sq. ft.	AFT 100 Crossroads Blvd. Bucyrus, OH 44820 419-562-1337	3.5” thick 16” or 24” wide R-13 Rating	Easy to handle, does not itch 100% recylable, reduces landfill waste No chemical irritants, no VOC, no formaldehyde, no harmful airborne particles Rapidly renewable resource	
Safecoat Brand Zero VOC White Paint 	Interior Paint	$37.95 per Gallon		AlerG Inc. www.alerg.com		Less than 250 grams per liter of VOCs (Volatile organic compounds) No formaldehyde, halogenated solvents, mercury, lead, cadmium or chromium	

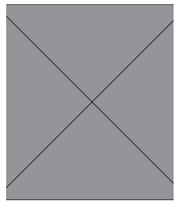
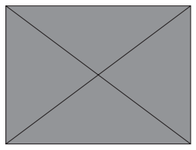
Materials and Equipment

MATERIAL	USED FOR	UNIT COST	AMOUNT	LOCAL DEALER	SPECS/SIZE	BENEFITS	PAY BACK TIME
Kruse Recycled Content Carpet 	All flooring but Kitchen and bathrooms	Comparably priced	309--1500 sq. ft. 317--2050 sq. ft.	Kruse Carpet Recycling 4800 West 96th St. Indianapolis, IN 317-337-1950	Made from recycled carpet and plastic. Nearly 50 2-Liter bottles go into a sq. yd.	Recycled fiber carpet are more stain resistant and have less VOC's and toxic off gassing	
Armstrong Linoleum Flooring 	Flooring in Kitchen and Bathrooms	$4 sq. ft.	309--500 sq. ft. 317--340 sq. ft.	Home Depot or Lowes	Not to be confused with vinyl or vinyl composition tile	Durable, low maintenance that performs better as it ages Natural product because its non-petroleum based and biodegradable, no toxic off gassing	
Harbor Breeze 52" Ceiling Fan 	Aid in ventilation	$45	309--7 Fans 317--8 Fans	Lowes	52" Blade Sweep 3 Speed Reversible 30 Year warranty	Energy Star Certified Reversible feature allows fan to aid in both heating and cooling	Simple payback of added cost is 0.6 years. (Using the saving calculator on the energy star website)
Rockton 12" Rough-in Round-Front Toilet with Dual Force Technology 	Water Saving Toilet	$230	309--3 units 317--4 units	The Great Indoors 11925 Commons Drive Springdale, OH 45246 513-346-1500	30" x 30" x 14"	Two different flushes saves water Uses .8 or 1.6 gallons of water Siphon was system	Average family of 4 saves up to 6,000 gallons of water per year

Materials and Equipment

MATERIAL	USED FOR	UNIT COST	AMOUNT	LOCAL DEALER	SPECS/SIZE	BENEFITS	PAY BACK TIME
Frigidaire Top Freezer Refrigerator 	Refrigerator	$419	309--2 units 317--2 units	Lowes	14.8 cu. ft. 31” x 28” x 60”	Energy Star Certified	Simple payback of added cost is 6.2 years. (Using the saving calculator on the energy star website)
Whirlpool Freestanding Electric Range 	Range and Stove	$250	309--2 units. 317--2 units	Lowes	3.5” thick 16” or 24” wide R-13 Rating		
Frigidaire Front Load Washer 	Washer	$593	309--2 unit 317--2 unit	Lowes	3.5 cu. ft. 27” x 28” x 36”	Energy Star Certified	Simple payback of added cost is 6.7 years. (Using the saving calculator on the energy star website)
Whirlpool Electric Water Heater 	Hot Water tank	$200	309--2 units 317--2 units	Lowes	40 Gallons 20” diameter 47” tall		

Materials and Equipment

MATERIAL	USED FOR	UNIT COST	AMOUNT	LOCAL DEALER	SPECS/SIZE	BENEFITS	PAY BACK TIME
Velus Rigid Sun Tunnel 	Additional Daylight	$162	309--2 units 317--2 units	Lowes	10” in diameter	Tubular skylight lets in an amazing amount of light with minimal invasion to the roof	
Rustic Metal Roof Shingles 	New Roof		309--840 sq. ft. 317--756 sq. ft.	Classic Metal Roofing 8510 Industry Park Dr. Piqua, OH 45356 1-800-543-8938	Energy Star Certified	98% recycled materials easy install, sheds snow/ice, resists streaking and staining and impervious to water absorption and nature Maintenance Free	Saves 20% on Summer cooling bill

ADDITIONAL NOTES:

An evacuated tube system was considered for hot water heating but was found not to be worth the cost because the Geoexchange system comes with a Desuper heater system that will already be used for heating water.

Propylene Glycol should be specified for use in the Geoexchange system in place of anti-freeze because it is a similar material but is rated “generally considered as safe” and is more environmentally friendly

Salvage Stores can be a source for other needed materials such as kitchen cabinets.

For lumber first reuse any interior studs that are not in use. Additional lumber can come from a place like Lowes.

Alternative to copper pipes were considered but most are made of some form of off gassing plastics so while the most expensive option is copper it is still the safest and most environmentally friendly.

General Budget

			309			317			
Material	**Unit Cost**		**Amount**		**Cost**	**Amount**		**Cost**	**Total Cost**
Small Casement Windows	$200	per window	3	windows	$600	0	windows	$0	$600
Large Casement Windows	$228	per window	9	windows	$2,052	20	windows	$4,560	$6,612
Double Hung Windows	$285	per window	9	windows	$2,565	3	windows	$855	$3,420
V-Kool Glazing Film	$5	per sq. ft.	120	sq. ft.	$600	60	sq. ft.	$300	$900
Salvaged Windows	$25	per window	35	windows	$875	35	windows	$875	$1,750
12Ft. Composite Decking	$22	per plank	34	Planks	$748	43	planks	$946	$1,694
16Ft. Composite Decking	$29	per plank	44	Planks	$1,276	12	planks	$348	$1,624
Cotton Insulation	$0.55	per sq. ft.	1800	sq. ft.	$990	2100	sq. ft.	$1,155	$2,145
Low VOC Paint	$37.95	per gallon							
Recyled Content Carpet			1500	sq. ft.		2050	sq. ft.		
Linoleum Floor	$4	per sq. ft.	500	sq. ft.	$2,000	340	sq. ft.	$1,360	$3,360
Ceiling Fan	$45	per unit	7	units	$315	8	units	$360	$675
Dual Flush Toliet	$230	per unit	3	units	$690	4	units	$920	$1,610
Refridgerator	$419	per unit	2	units	$838	2	units	$838	$1,676
Stove	$250	per unit	2	units	$500	2	units	$500	$1,000
Washer	$593	per unit	2	units	$1,186	2	units	$1,186	$2,372
Hot Water Heater	$200	per unit	2	units	$400	2	units	$400	$800
Sun Tube	$162	per tube	1	tube	$162	0	tubes	$0	$162
Roofing			840	sq. ft.		756	sq. ft.		
Geoexchange system	$15,000	per unit	1	unit	$15,000	1	unit	$15,000	$30,000
Grand Total					$30,797			$29,603	$60,400

LEED™ Points

LEED™ Project Checklist

Sustainable Sites

14 Possible Points

N	M	Y			
		X	Prereq 1	**Erosion & Sedimentation Control**	Required
		X	Credit 1	**Site Selection**	1
		X	Credit 2	**Urban Redevelopment**	1
	X		Credit 3	**Brownfield Redevelopment**	1
		X	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
		X	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
X			Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
X			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
		X	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
		X	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
		X	Credit 6.1	**Stormwater Management**, Rate and Quantity	1
	X		Credit 6.2	**Stormwater Management**, Treatment	1
		X	Credit 7.1	**Heat Island Effect**, Non-Roof	1
		X	Credit 7.2	**Heat Island Effect**, Roof	1
	X		Credit 8	**Light Pollution Reduction**	1

LEED™ CREDIT EXPLANATIONS

Note: This project is evaluated on the basis of the LEED-NC (New Construction) rating system because it was the most relevant standard available at the time this project began. However, the forthcoming LEED-H (LEED for Homes) may prove more applicable, and might in fact yield a higher score (since several of the points in LEED-NC are targeted toward larger projects and are therefore not applicable). It is also possible that this development could be a pilot project for the LEED-H rating system.

Sustainable Sites 14 Possible Points

Prereq 1 **Erosion & Sedimintation Control:** Earned
PhD soil type stabilized with permanent seeding on slopes (see site plan).

Credit 1 **Site Selection:** Earned
Site is not prime farmland, public park, less than 5 ft. above the 100-year flood level, or within 100 ft. of water.

Credit 2 **Urban Redevelopment:** Earned
Site is located within an existing urban infrastructure with a development density of greater than 60,000 square feet per acre (see context plan).

Credit 3 **Brownfield Redevelopment:** Possible
This site might be considered a brownfield due to its prior use. This credit requires proof of brownfield states either from ASTM E1903-97, OR from a letter from a local, state, or federal agency, AND that the site be remediated.

Credit 4.1 **Alternative Transportation, Public Transportation Access:** Earned
The site is within 1/4 mile of two or more bus lines.

Credit 4.2 **Alternative Transportation, Bicycle Storage & Changing Rooms:** Earned
Covered bicycle storage has been provided for nearly 50% of residents (greater than the 15% required minimum).

LEED™ Points

Credit 4.3 **Alternative Transportation, Alternative Fuel Vehicles:** N/A
Not applicable to a residential project without parking facilities.

Credit 4.4 **Alternative Transportation, Parking Capacity:** N/A
Not applicable to a residential project without parking facilities.

Credit 5.1 **Reduced Site Disturbance, Protect or Restore Open Space:** Earned
Site plan calls for replanting over 50% of the site area (excluding building footprint) with native or adapted vegetation.

Credit 5.2 **Reduced Site Disturbance, Development Footprint:** Earned
Site plan designates open space adjacent to the buildings (specifically, additional purchased lots to the south and west), which amount to greater than 25% greater than local zoning requirements.

Credit 6.1 **Stormwater Management, Rate & Quantity:** Earned
The proposed design would not increase the 1.5 year 24-hour peak discharge rate because the amount of impervious surface has not been changed.

Credit 6.2 **Stormwater Management, Treatment:** Possible
This credit requires either the elimination of runoff or the elimination of contaminants. The former could be achieved with off-site bioswales. (These would have to be off-site because of the sloping topography; a move that would incur additional land costs.)

Credit 7.1 **Heat Island Effect, Non-Roof:** Earned
Over 30% of the non-roof impervious surfaces on the site plan are either high-albedo or shaded. In fact, there is very little non-roof impervious surface: the raised decking allows water absorption. Existing sidewalks, are the only impervious surface, are shaded by street trees (see site plan).

Credit 7.2 **Heat Island Effect, Roof:** Earned
100% (greater than the required 75%) of the roof surface is highly reflective and high emissivity. (Green roofs were considered but found impractical for this application.)

Credit 8 **Light Pollution Reduction:** Possible
Exterior light fixtures have not been specified and lighting calculations have not been performed, but the minimal need for exterior lighting makes this credit very possible to achieve.

LEED™ Points

Water Efficiency

5 Possible Points

N	M	Y			
		X	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
		X	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
	X		Credit 2	**Innovative Wastewater Technologies**	1
		X	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
		X	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Energy & Atmosphere

17 Possible Points

N	M	Y			
		X	Prereq 1	**Fundamental Building Systems Commissioning**	Required
		X	Prereq 2	**Minimum Energy Performance**	Required
		X	Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
		X	Credit 1	**Optimize Energy Performance**	6 (of 10)
X			Credit 2.1	**Renewable Energy**, 5%	1
X			Credit 2.2	**Renewable Energy**, 10%	1
X			Credit 2.3	**Renewable Energy**, 20%	1
	X		Credit 3	**Additional Commissioning**	1
		X	Credit 4	**Ozone Depletion**	1
X			Credit 5	**Measurement & Verification**	1
	X		Credit 6	**Green Power**	1

Water Efficiency 5 Possible Points

Credit 1.1 **Water Efficient Landscaping, Reduce by 50%:** Earned
Credit 1.2 **Water Efficient Landscaping, No Potable Water Use or No Irrigation:** Earned
Stormwater is collected for irrigation of vegetable gardens; and irrigation of the yard and landscaping should not be necessary because native and adapted vegetation has been specified.

Credit 2 **Innovative Wastewater Technologies:** Possible
While graywater systems reduced water use by an average of 33.5%, they have not yet met the required 50% reduction in sewage volume. This could be accomplished by a blackwater system (budget permitting). (See graywater system for more information.)

Credit 3.1 **Water Use Reduction: 20% Reduction:** Earned
Credit 3.2 **Water Use Reduction, 30% Reduction:** Earned
Potable water use is reduced by 31% in 309 Mulberry and 34% in 317 Mulberry. Design strategies include a dual-plumbing for graywater in toilets, as well as low-flow fixtures (including dual-flush toilets).

Energy & Atmosphere 17 Possible Points

Prereq 1 **Fundamental Building Systems Commissioning:** Earned
Assumed to be specified if project is completed.

Prereq 2 **Minimum Energy Performance:** Earned
Compliance with ASHRAE/IESNA Standard 90.1-1999 has been assumed based upon the following design strategies: added insulation in building envelope, replacement windows, minimal HVAC systems, solar hot water heating, extensive daylighting, and energy-efficient applicances. Calculations must be performed to confirm these assumptions (and to earn the credit), but the necessary software was not available to us.

LEED™ Points

Prereq 3 **CRC Reduction in HVAC&R Equipment:** Earned
Specified equipment (including refrigerator units and the geo-exchange system) do not use CFC-based refrigerants.

Credit 1 **Optimize Energy Performance:** Earned (6 of 10)
Six of ten possible credits have been assumed to be earned based upon the following design strategies: added insulation in building envelope, replacement windows, minimal HVAC systems, solar hot water heating, extensive daylighting, passive ventilation, passive solar heating, geo-exchange heating and cooling, earth berming, and energy-efficient applicances. Calculations must be performed to confirm these assumptions (and to earn the credit), but the necessary software was not available to us.

Credit 2.1 **Renewable Energy, 5%:** N/A
Credit 2.2 **Renewable Energy, 10%:** N/A
Credit 2.3 **Renewable Energy, 20%:** N/A
These credits have been deemed inappropriate for low-income housing because of the high cost of on-site renewable energy. If funding became available for roof-mounted photovoltaic panels, these could be added to the design.

Credit 3 **Additional Commissioning:** Possible
Additional commissioning could be specified if the project is completed, depending on budgetary limitations.

Credit 4 **Ozone Depletion:** Earned
Specified equipment (including refrigerators, insulation, and the geo-exchange system) contains no HCFCs or halons.

Credit 5 **Measurement & Verification:** N/A
This credit requires installing continuous metering equipment to monitor energy and water consumption; this was deemed inappropriate for a low-income residential project. However, in its capacity as a demonstration project, such equipment may indeed be appropriate, in which case the equipment could easily be added.

Credit 6 **Green Power:** Possible
This credit requires that at least 50% of grid electricity be from renewable sources by engaging in a two-year renewable energy contract. Although this is a decision made by the tenants, it was considered a more feasible option that on-site renewable energy.

LEED™ Points

Materials & Resources

13 Possible Points

N	M	Y			
		X	Prereq 1	**Storage & Collection of Recyclables**	Required
		X	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
		X	Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
X			Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
	X		Credit 2.1	**Construction Waste Management**, Divert 50%	1
	X		Credit 2.2	**Construction Waste Management**, Divert 75%	1
		X	Credit 3.1	**Resource Reuse**, Specify 5%	1
		X	Credit 3.2	**Resource Reuse**, Specify 10%	1
	X		Credit 4.1	**Recycled Content**, Specify 5% (p.c. + 1/2 p.i.)	1
	X		Credit 4.2	**Recycled Content**, Specify 10% (p.c. + 1/2 p.i.)	1
	X		Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
	X		Credit 5.2	**Local/Regional Materials**, of 20% in 5.1, 50% Harvested Locally	1
		X	Credit 6	**Rapidly Renewable Materials**	1
	X		Credit 7	**Certified Wood**	1

Materials & Resources 13 Possible Points

Prereq 1 **Storage & Collection of Recyclables:** Earned
Areas for storage of recyclables have been provided in the kitchens and on the site. Recycling collection is provided by the city.

Credit 1.1 **Building Reuse, Maintain 75% of Existing Shell:** Earned

Credit 1.2 **Building Reuse, Maintain 100% of Existing Shell:** Earned
The proposed design calls for maintaining nearly all of the existing shell (a measure that excludes windows and non-structural roofing). Changes to the shell include: new punched openings on the eastern façades and a removal of the roof dormer on 317 Mulberry.

Credit 1.3 **Building Reduce, Maintain 100% Shell and 75% Non-Shell:** N/A
The proposed design calls for complete renovation of the building interior, a design that precludes maintaining non-shell. While some materials are salvaged (e.g., wood studs), these are only applicable under MR Credit 3: Resource Reuse (below).

Credit 2.1 **Construction Waste Management, Divert 50% from Landfill:** Possible

Credit 2.2 **Construction Waste Management, Divert 75% from Landfill:** Possible
There is adequate room on-site for separation of construction waste. A Waste Management Plan could be developed for this project, and wastes could be recycled at several of the existing salvage stores in Cincinnati.

Credit 3.1 **Resource Reuse, Specify 5%:** Earned

Credit 3.2 **Resource Reuse, Specify 10%:** Earned
Reused materials include wood studs for interior walls, “green bollards” for landscaping, and salvaged windows from which the “Trombe walls” are constructed. Doors, frames, and masonry could all be purchased from local salvage stores.

LEED™ Points

Indoor Environmental Quality

15 Possible Points

N	M	Y			
		X	Prereq 1	**Minimum IAQ Performance**	Required
		X	Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
X			Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
		X	Credit 2	**Ventilation Effectiveness**	1
	X		Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
	X		Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
		X	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
		X	Credit 4.2	**Low-Emitting Materials**, Paints	1
		X	Credit 4.3	**Low-Emitting Materials**, Carpet	1
		X	Credit 4.4	**Low-Emitting Materials**, Composite Wood	1
X			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
		X	Credit 6.1	**Controllability of Systems**, Perimeter	1
		X	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
	X		Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
X			Credit 7.2	**Thermal Comfort**, Permanent Monitoring Systems	1
		X	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
		X	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Credit 4.1 **Recycled Content, Specify 5%:** Possible
Credit 4.2 **Recycled Content, Specify 10%:** Possible
Recycled content carpet has been specified, as well as recycled gypsum wallboard and recycled content composite decking (see materials for more information), but it uncertain what percentage of the final budget these materials represent.

Credit 5.1 **Local / Regional Materials, 20% Manufactured Locally:** Possible
All materials for this project are manufactured or sold within a 500-mile radius of the site. (See materials list for more details.)

Credit 5.2 **Local / Regional Materials, of 20% above, 50% Harvested / Extracted Locally:** Possible
Cotton and wood might be available from local growers.

Credit 6 **Rapidly Renewable Resources, 5%:** Earned
Cotton batt insulation, a rapidly renewable materials, is specified in lieu of traditional fiberglass batt insulation.

Credit 7 **Certified Wood:** Possible
Certified wood could be specified for new stair construction, roof- and floor-joist replacement, and "Trombe wall" construction, costs permitting.

Indoor Environmental Quality 15 Possible Points

Prereq 1 **Minimum IAQ Performance:** Earned
Compliance with ASHRAE 62-1999 and Addenda assumed based upon passive ventilation design and calculations. ASHRAE's Ventilation Rate and Indoor Air Quality calculations would have to be performed to verify this assumption.

Prereq 2 **Environmental Tobacco Smoke (ETS) Control:** Earned
Smoking in these units is assumed to be prohibited. Covered areas are provided outdoors to accommodate smokers.

LEED™ Points

Credit 1 **Carbon Dioxide (CO2) Monitoring:** N/A
This credit calls for the installing of monitors and additional HVAC equipment, which we considered inappropriate and prohibitively costly for a residential project.

Credit 2 **Ventilation Effectiveness:** Earned
The laminar air flow pattern involves a minimum of 90% of occupied rooms for 95% of occupied time, based upon air flow diagrams. Verification, either via performing testing after construction or by conduction airflow simulations, would have to be completed to achieve this credit.

Credit 3.1 **Construction IAQ Management Plan, During Construction:** Possible
Credit 3.2 **Construction IAQ Management Plan, Before Occupancy:** Possible
An Indoor Air Quality Management Plan could be developed and implemented for this project, costs permitting.

Credit 4.1 **Low-Emitting Materials, Adhesives & Sealants:** Earned
Credit 4.2 **Low-Emitting Materials, Paints:** Earned
Credit 4.3 **Low-Emitting Materials, Carpet:** Earned
Credit 4.4 **Low-Emitting Materials, Composite Wood:** Earned
Specified paints have no VOC, specified carpet has low VOC content. Composite wood decking uses no urea-formaldehyde resins. Compliance with specific standards has been assumed but has not yet been demonstrated.

Credit 5 **Indoor Chemical & Pollutant Source Control:** N/A
This credit is inappropriate for a residential development.

Credit 6.1 **Controllability of Systems, Perimeter:** Earned
Credit 6.2 **Controllability of Systems, Non-Perimeter:** Earned
The scale of these buildings means that all space is “perimeter” (that is, within 15 ft. of the perimeter wall). All inhabited spaces have operable exterior windows and lighting controls.

Credit 7.1 **Thermal Comfort, Comply with ASHRAE 55-1992, Addenda 1995:** Possible
This credit requires compliance with the adaptive comfort temperature boundaries found in the Collaborative for High Performance Schools (CHPS) Best Practices Manual, Appendix C. Compliance has not yet been verified.

Credit 7.2 **Thermal Comfort, Permanent Monitoring System:** N/A
Projects utilizing natural ventilation cannot earn this credit because humidity control is not achievable in naturally ventilated buildings.

Credit 8.1 **Daylight & Views, Daylight 75% of Spaces:** Earned
Existing and new windows provide adequate daylighting. (See daylighting diagrams.)

Credit 8.2 **Daylight & Views: Views for 90% of Spaces:** Earned
Existing and new windows provide views for all spaces. (See view diagrams.)

LEED™ Points

Innovation & Design Process

5 Possible Points

N	M	Y			
	X		Credit 1.1	**Innovation in Design**, Low-Income Housing	1
		X	Credit 1.2	**Innovation in Design**, Reused Materials	1
		X	Credit 1.3	**Innovation in Design**, Geo-exchange System	1
X			Credit 1.4	**Innovation in Design**	1
		X	Credit 2	**LEED™ Accredited Professional**	1

Project Totals

69 Possible Points

Action	SS	WE	EA	MR	EQ	ID	TOTAL
Y (Earned)	9	4	7	5	9	3	**37**
M (Possible)	3	1	2	7	3	1	**17**
N (N/A)	2	0	4	1	3	1	**11**

Total Earned: 37 points = **LEED Silver**
Possible + Earned: 54 points = **LEED Platinum**

Innovation & Design Process 5 Possible Points

Credit 1.1 **Innovation in Design, Low-Income Housing:** Possible
This innovation credit is proposed in order to acknowledge the element of socio-cultural sustainability added by the low-income and ADA accessible aspects, which are above and beyond what is required. Considered "possible" because it is not directly related to energy or environmental performance.

Credit 1.2 **Innovation in Design, Reused Materials:** Earned
This innovation credit is proposed because of the high percentage of reused / salvaged materials used on this project.

Credit 1.3 **Innovation in Design, Geo-exchange System:** Earned
This innovation credit is proposed to acknowledge the geo-exchange system, which has numerous environmental benefits: it is energy efficient, utilizes renewable energy, and (in concert with the passive systems) eliminates the need for energy-consuming HVAC systems. The desuperheater (included) also pre-heats domestic hot water, reducing energy required to run hot water heaters.

Credit 1.4 **Innovation in Design:** N/A
There are no other innovation proposals for this project.

Credit 2 **LEED Accredited Professional:** Earned
Team member Carl Sterner is a LEED Accredited Professional.